# Information Technology in Educational Management

Edited by

**Ben-Zion Barta, Moshe Telem and Yaffa Gev**

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# CONTENTS

**Preface** ix

## PART ONE Issues in Information Technology in Educational Management

1 Maximizing the potential of information technology for management: strategies for interfacing the technical core of education 3
*C.L. Fulmer*

2 Information technology assimilation in schools: a theoretical and practical framework 9
*M. Telem and B.-Z. Barta*

3 Computer assisted school administration and management: where are we and where should we go? 15
*A.J. Visscher*

4 The use of task analysis and user acceptability audits in implementing information technology systems in schools 27
*P. Wild*

## PART TWO Implementation Status – National Reports

5 Managing change in "ITEM" 37
*A.C.W. Fung*

6 ISE – information systems in education 46
*Y. Gev*

7 Case study of the Information Systems Strategy (ISS) of the Hong Kong Education Department 50
*S.H. Hsu*

8 Computer-aided school management in North-Rhine Westphalia: The Kaufmaennische Schulen (College of Commerce) in Ahaus 56
*G. Kuhlmann*

9 The development of computer assisted school administration in New Zealand: a case study 63
*P.C.J. Nolan*

10 School management information system authority in Israel 79
*I. Sagi, Y. Gev and A. Feinmesser*

11 The development of ITEM in England and Wales 85
*I.D. Selwood*

12 Information technology in educational management of Nepal 93
*H.G. Shrestha*

13 Information technology and the management of Victorian schools – providing flexibility or enabling better central control? 99
*A. Tatnall*

14 State of the art in information technology in educational management in the Czech Republic 109
J. *Vaníček and A. Nohejlová*

**PART THREE Higher Education**

15 Interactive voice response – more power to students 117
*G. Burton*

16 CASMAC – a co-operative approach to university administrative computing 122
*H. Dimmit*

17 DUX: a remote-access on-line information system 128
*P. Juliff*

18 The Queensland Tertiary Admissions Centre: an example of a cooperative system using state of the art technologies 136
*A. McClelland*

19 Contribution of the information technology/information systems to human resources management in the university 139
*J. Rodríguez, J. Osorio and R. Berriel*

**PART FOUR Educational Decision Support Systems**

20 "Sheshet" – decision support system for guidance and placement of enrolling high school students 147
*P. Kalay and D. Chen*

21 Geographic information and school facility planning 153
*R.G. Taylor*

22 Interactive simulation for planning, coordination and control: mathematical decision support systems in education 162
*B.E. Wholeben*

23 Computerized support in decision-making processes in Israeli schools 170
*I. Yahalom*

**PART FIVE Specific Applications**

24 Information technology and the management of instructional programs: meeting the challenge of curriculum-time compression in schools 179
*J.E. Bruno*

25 Schedule planning by using genetic algorithms for developing educational materials and curricula 187
*T. Kado and S. Komya*

26 The use of information technology in educational counselling: applications for high school counsellors 195
*Y.J. Katz and B. Offir*

27 Having an "assistant" makes better teaching 201
*N. Netz*

28 Educational management in Israeli elementary schools 209
*L. Osin*

29 Education management – information technology and school autonomy 215
*I. Rubinstein*

30 The computer as decision making tool in the Junior High School 220
*N. Sternheim*

31 Educational resource management with a human interface 225
*T. Paturi*

**PART SIX Panels and Discussions – Summaries**

32 Information technology in educational systems: Where are we? Where are we going? 233

33 Introduction of IT in school management: approaches, preparation human and political aspects 235

34 ITEM as a catalyst for school reform 238

35 Pedagogical decision making in a computerized school environment 242

36 Telecommunications in educational administration and management of learning in higher education 246

**Index of contributors** 249

**Keyword index** 250

# PREFACE

Educational institutions in which administrators, managers and teachers will be working in the late 1990's will be far different from those of today.

Schools, which until recently were lagging behind in the implementation of information technology (IT) in their administration and management, are now attempting to close the gap. A massive and rapid computerization process in schools, school districts and throughout the other levels of the educational system, including universities, has made computers an integral part of the educational management scene. A computer on the desk of every educational management staff might become a reality in the near future.

The term "IT" includes three main components: hardware, software - mainly management information systems (MIS)/decision support systems (DSS) and human factors. Presently, successful implementation depends on adequate software and on human factors.

MIS/DSSs are being implemented with the aim of providing meaningful support for school employees in their daily activities, and to improve their performance, effectiveness and efficiency. Much like at universities, usable and accessible school databases are being established, encompassing data on students, teachers, employees, classrooms, grade levels, courses, student achievements and behavior, school space, curriculum, finance, inventory, transportation, etc. The MIS provides school employees with new tools which should support them in a variety of activities such as student placement , teacher allocation to classes, construction of school timetables and examination schedules, assignment and disbursement of resources, follow-up on decision implementation, analysis of teacher and school achievements, etc. IT implementation is also invigorated by office automation tools such as word processing, electronic mail, electronic archives, spreadsheets, automatic follow-up of decisions, electronic appointment books, automatic dialing, desk-top publishing, etc. Although their entrance to schools is still slow-paced, it is reasonable to assume that these tools will quickly become routine in the schools, as they have already done in universities.

The purpose of this working conference on Information Technology in Educational Management (ITEM) is to examine the state of the art in various countries with regard to primary and secondary schools and in institutes of higher education, and to serve as a stage for the exchange of ideas, knowledge, and experience accumulated in the various countries.

The initiative and the preliminary idea of the conference came from the Department of Information Systems in Education at the Israeli Ministry of Education. IFIP's Working Group 3.4 - Education and Training of Information Technology Professionals and Advanced End-Users - decided to support this initiative and to sponsor the conference. ITEM is an important issue for efficient and effective management of any educational institution , including those dealing with education for the computer professions. Nevertheless, training and educating towards advanced applications of ITEM systems is of paramount importance for successful implementation. Obviously, training of these advanced end-users - principals, teachers, school-staff is not only within the range of the group, but actually constitutes one of its major aims.

The Israeli Information Processing Association, which is the body representing Israel in the IFIP, and the Israel Local Authorities Data Processing Association - dealing among other issues with the computerization of educational management at Israel's local authorities - joined the sponsors and supporters of the conference . A group of institutions, part of them non-profit institutions, others commercial and industrial firms, also decided to support the initiative, and it is the common effort of all these that made this conference possible.

The wide spectrum covered by "Information Technology in Educational Management" is reflected by the papers collected in the five sections of these proceedings and by the summaries of the discussion groups and the panel discussion which are also included.

**Concepts and issues** related to ITEM (Section 1) deals with an assessment of the state of the art and with a forecast of developments. Subsequently some evaluation approaches are raised , and finally, human aspects are discussed, emphasizing again that acceptance and good understanding of systems' capabilities are main factors of success. Education and training should be adequately developed.

**National reports** on the status of ITEM (Section 2) could be divided in to two groups. The first includes countries already implementing ITEM to a large extent, and seeking for real, full-scale implementation, on one hand, and for advanced applications, on the other. The second group consists of countries that are at some - more or less advanced - starting phase on the way to introducing computers in their educational administration and management.

Papers referring to **higher education** (Section 3) reflect the trend to provide students with phone-line access for automated services otherwise provided by personal contact. Other papers in this section report a computer support for better management and development of human resources.

**Educational Decision Support Systems.**, which eventually will play increasingly important roles in educational systems, are mentioned in Section 1 (Concepts and issues), and also, by dedicated papers, in Section 4. Some of these papers refer, in general, to applications for schools and educational authorities while others refer to special-purpose EDSS application.

Section 5 refers to **specific applications** like processing of students' grades and other personal data for generating reports for the benefit of teachers, principals, counselors, and educational system managers, on one hand, and to management and scheduling of teaching, of development and of educational resources, on the other.

The reports on the discussion groups and the panel that followed the presentations represent a valuable add-on to the subjects covered by the papers and an indication of the trends and prospects described by the experts participating in the Working Conference.

The conference proved useful to the participants and it is our hope that the proceedings will provide a valuable source of information to those interested and involved in Information Technology in Educational Management. This in itself is the main reward for all persons and institutions that initiated, supported and provided the leadership to run the conference, the chairpersons and members of the conference organizing committee, the program committee and all the administrative staff who helped in various ways.

Special appreciation is to be extended to Mrs. Miriam Hadar and Mrs. Chantal Ben Loulou for their dedication in bringing this volume to its final shape.

Finally, thanks are due to all the authors and participants who contributed to the conference and to these proceedings. These people and their joint efforts were the "raison d'etre", the soul of the conference.

The editors.

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## PART ONE

# Issues in Information Technology in Educational Management

# 1

# Maximizing the Potential of Information Technology for Management: Strategies for interfacing the Technical Core of Education

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## Abstract

The impact of information systems will be maximized when the capacity of the technological architecture and system design are capable of interfacing with the technical core of education. The technical core of education is defined as the interface between the student and the contexts in which they acquire or generate knowledge. The author provides a vision of an integrated information system with (a) multiple input ports, (b) alternative units of analysis for inquiry, (c) variable types of data, (d) choice of analytic processes, and (e) variable access ports for retrieval of data. The author argues that this vision becomes a reality when the system is designed through an inductive process that includes stakeholders from all levels of the organization. To achieve this vision of an integrated information system, educators and information systems specialists need to find ways to integrate the capacity of the information technology with the work and the work life of the technical core and its participants.

Key Codes: H.1.2; K.3.1; J.1
Keywords: Information Systems, User/Machine Systems; Computing Milieu, Computer Uses in Education; Computer Application, Administrative Data Processing

## 1. INFORMATION SYSTEMS AND EDUCATIONAL IMPACT: AN INTEGRATED VISION

This paper makes the argument that the potential of information systems will be maximized when the capacity of the technological architecture and system design are capable of affecting the teaching and learning process or the technical core of educational organizations. Much has been written about statistical process controls and productivity in manufacturing facilities but to date not much has been done or has been written about information systems impacting productivity in educational settings. What is required is a shift in focus from the management of information to the support of the work of the technical core, teaching and learning.

### 1.1. Instrumental shortfall of existing information systems

In spite of spectacular technological advances and the recently touted *hyperlearning* [1] that threatens to make schools as we know them today obsolete, or promises technologically to deschool learning [2], the established educational response has been minimal. In spite of the research to the contrary, schools still persist in the process of *tracking students* through homogenous grouping policies. This is especially unfortunate, since the technology exists to track, instead, the progress of individual students as they work cooperatively in multi-aged, integrated-curricular project work groups. Such a system could provide data that would permit teachers to group students for instruction based on the learning activities of the preceding day. There are many reasons for this current state of affairs, but the consequence is that information systems in educational organizations fall short of the support required for active and productive teaching and learning experiences for teachers and children.

Information tends to be *archived* rather than *data-based.* When archieved is typically not readily available to the decision makers. For example, attendance information might be codified and stored in a system that has no interface with educational productivity data: test scores, grades, norm referenced achievement data, or criterion referenced cognitive, affective, or psychomotor skills. Similarly, educational expense data, balanced and organized by quarterly or annual budget deadlines have no interface with units or measures of student learning. Therefore, information systems while meeting the expectation of storing student productivity data and other relevant information, have not had much of an impact on educational productivity.

## 1.2. Misplaced focus on management of information

Perhaps the best explanation for this problem was offered by Zuboff [3] in her work on how computers alter the work of organizations. Technology can be used to *automate* the processes of the present day to day operations. The process of automation serves to perform tasks with great speed and accuracy. In schools where the attendance process has been automated another level of bureaucratic paperwork has been created in order to keep the system functioning. When attendance was manually derived, each teacher kept records at her desk on a paper spreadsheet register. Student attendance or non attendance was recorded for a yearly attendance period. At the end of the year, this summary data was transferred by hand to a building record. Next, building records were aggregated, by hand, at the district level. The automated system of taking attendance required teachers to send daily attendance lists to central office. A clerk was then hired to enter the attendance information into a computer. The reports generated by this technology were purposely designed to be identical to the original paper and pencil record. In the automated mode, computers calculated daily average attendance data by class, building, and district at a much faster rate. However, inspite of the speed and accuracy in calculations, the intent of the system to *manage* the information remained the same.

A more productive way of using technology in this attendance example is what Zuboff [3] called the process of *informating*or the process of using information to reconfigure work and the social relationships of production. In the attendance example outlined above, a system that informated would provide more information than average daily attendance figures. Instead, it would illuminate patterns of attendance of individual students that are related to days of the week, times of the year, teacher testing patterns, or other relevant variables that would affect student behavior and productivity. In the original manual attendance method, only the individual classroom teacher had access to the attendance data. In the second, or automated method, only the clerk responsible for attendance input data had access to the information. If attendance data were entered into an informating system, the work surrounding the processes of taking attendance would be altered. As altered, the new work would serve both the teacher and administrator in the educational use of these data. Unfortunately, when and if technology is used in schools, it is typically in the mode Zuboff described as automated.

### 1.3. Analytic power of an integrated system

An integrated information system is defined in this paper as one that integrated the processes of automation with the processes of informating. Visscher [4] claimed that soon computer applications for schools will be developed that make new forms of decision support a reality. Relational databases and fourth generation languages become policy making tools when they are utilized to make sense out of system data. For example, the system could be used to find the relation between attendance data, truancy figures, scheduling practices, and student productivity data.

The first step in achieving this vision is to design a system with the potential for *multiple input ports*. In the attendance example, the manual method of taking attendance impeded the administrative use of the data at the building or district level. Data was not available except at specific report period times. However, the automated system, while convenient for administrative use, removed data from the domain of the teacher's decision making sphere. A system designed with multiple ports of access for entry and retrieval of data would permit information systems to function in an informating as well as in an automating mode.

Secondly, the system must be capable of aggregating data into *alternative units of analysis* for purposes of inquiry. In addition to attendance coded at the individual student level, other units of analysis such as ethnic, gender, or socio-economic economic status could be used to aggregated data for purposes of system inquiry. Are there specific groups of students either attending or absenting classes. Rather than merely managing data, an integrated system should be capable of generating answers to questions asked by policy makers, building principals, or teachers concerned by attendance patterns of individual children, groups or categories of children, or organizational divisions within a particular school district.

A third step in designing an integrated information system is to provide for *multiple types and forms of data*: (a) nominal, (b) ordinal, (c) interval ratio, (d) qualitative, (e) biographic, (f) self-evaluation data, (g) samples of writing, (h) student journals, parent feedback, or (j) other forms of student attitude, performance, or productivity. As technology becomes simultaneously more powerful, smaller, and more transportable, learning environments could be networked. Traditional student materials, paper, sketchbooks, notebooks could be replaced by electronic data entry screens. Work in progress, student answers, test scores, verbal responses, and patterns of responses could be data-based for subsequent or instantaneous analyses by from multiple organizational levels.

Alternative types of data and variable units of analyses provide the potential for the fourth step in this integrated information system, the *choice of analytic process*. It is necessary for members of different organizational levels to require different types of data for decision making [5]. It is also necessary, although difficult for different levels of inquiry to require different modes of inquiry [6]. Would summary data be appropriate for making this decision? Or is descriptive information what is required for this type of problem? Would time analysis data provide more useful information for this particular issue? Or does the issue in question require multiple modes of inquiry and multiple types of analyses as well?

An integrated information system as defined in this paper would provide for analytic process choices.

Finally, an integrated system would need to provide users with *variable levels of access for retrieval* of data or data analyses. The technical core of education, or the student and learning environment interface, requires enormous amounts of decision making on the part of the teacher. An integrated information system would provide the support for analytic decision processes of system data at any organizational level. When designed in this manner, decisions at the classroom level are valued as being just as salient as those decisions made at the policy levels of the organization.

### 1.4. Simultaneous construction from multiple organizational levels

An integrated information system is the missing link between the administration of an educational organization and the contexts of learning. This process of knowledge acquisition or generation can be monitored or guided by the integrated system described in this paper. This system however, must be generated by members from every functional level of the organization. The process of generating each information system will alter the way the work is presently conducted in that particular organization. Administrators, teachers, and students will take on new roles [7]. Students will become more active participants in the data input processes as they participant in learning activities. In any event, this vision becomes a reality when the system is designed through an inductive process that includes stakeholders from the technical core through the executive and policy levels. Strategic planning processes are imperative and will need to focus on multiple and simultaneous levels of input, analysis, and data retrieval [8] to and from the technical core of educational organizations.

## 2. THE POWER OF INTERFACING WITH THE TECHNICAL CORE

The educational impact of information systems will be maximized when the capacity of the technological architecture and system design is capable of interfacing with the technical core of education. Much of what teachers do is invisible to an observer. Decision making many times is intuitive and based on thousands of other decisions made by the teacher's human computer, the brain. Quite often we mistakenly require, encourage, or demand that teachers reduce this rich and conceptually complex data to letter grades as a direct result of the sociological power of the report card. The technical core is the very heart of the education process. An integrated system has the potential to support teachers' and administrators' work. Information systems can rescue complex student data before it is reduced for administrative purposes or parental convenience.

### 2.1. The technical core of education defined

The technical core of education has been defined in this paper as the interface between the student and the contexts in which they learn or generate knowledge. Thompson [9] describes three types of technical cores of complex organizations: (a) long-linked, (b) mediating, and (c) intensive. Schools exhibit characteristics of all three. Creating the interface with a long-linked technical core is the easiest to achieve. Characteristics of this type include serial interdependence, repetition, a constant rate of production, and standardization. Examples of school data of a long-linked nature would be report card grades, yearly test data, and medical records. Presently, many information systems are long-linked systems designed for the management of information.

The second type, the mediating technical core, is described as operating in standardized ways with multiple clients or consumers distributed in time and space. Examples of data from a mediating technical core would be information on specific types of groups of students. For example: (a) third, eighth, and eleventh grade achievement test data, (b) pre-school admissions testing results, (c) physical examination records, and/or (d) special education student's individualized education plans (IEPs). While slightly more complicated, the interface required for the mediating technical core is similar to the long linked technology. Once constructed, these automated information systems operate over time, routinely, with multiple types, groups, or levels of data. Systems designed to interface with long-linked or mediating types of technical cores, unfortunately are designed to function as automated systems.

## 2.2. The missing link: An interface with the intensive nature of the technical core

The intensive technical core, as described by Thompson [9] is quite different from the first two. He compares it to an emergency room in a hospital where feedback from the patient is used to determine which treatment from a variety of treatments is appropriate for the medical problem. The characteristics of an intensive technical core sound very much like the description of Zuboff's [3] term *informating.* The technical core of education organizations in reality function in an intensive fashion even though they are structurally conceived of as long-linked and mediating processes. The intensive type of technical core would be best served by the integrated information systems described above. Such a system would be able to automate and informate. However, it is much easier to develop the integrated system than it will be to actually develop and implement an interface an intensive technical core. But this is exactly what must be done if information systems are to maximize their potential to impact education organizations. The interface will make it possible for the integrated system and its human partners to collect data, automate processes, and informate the work of multiple decision makers from different organizational levels. While a few of these systems may exist in various stages of development, they are largely absent from educational organizations. This author argues that the level of educational impact of an information system is enhanced when the system is able to accommodate the dual processes of *automating and informating.* Such a system is in fact integrated and therefore capable of interfacing with the complexities of the intensive technical cores found in educational organizations.

## 2.3. Building a system that supports the work of the technical core

In order to create a systems as envisioned above, the system must be designed to support and inform the work of the technical core. The process of *automating* the work tha is presently being done will precede the work on *informating* and potentially alter the actua work of the technical core. As teachers and students gain access to the complexities of teaching and learning processes and products through an integrated information system, decisions that affect learning could be made minute by minute as opposed to quarterly or annually. Work processes would more closely approximate the intensive type of technical core described by Thompson [9]. When we are able to merge the realities of technology and the educational work of teaching and learning, we will have achieved an integrated information system that supports the work of the technical core and therefore impacts educational productivity.

## 3. ISSUES FOR EDUCATORS AND INFORMATION SPECIALISTS

In order for technology to interface with the technical core of educational organizations, educators and technologists or information systems specialists need to merge the realities of each of their worlds. The teachers and administrators need to become acquainted with the capacity of the software and hardware of integrated information systems. Accordingly, information systems specialists need to start at each level of the organization and draw out the complexities of present modes of working to determine how the technology can be used for the purposes of informating the work environment. The process of creating the system envisioned in this paper will modify the realities of both the work environment and the design of the information system. When an inductive process is brought to bear on the problems of integrating technology with educational productivity, information systems will move beyond the management information, move beyond automating existing practices, and move toward informating or maximizing the potential of information systems to affect the technical core of educational organizations.

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# Information Technology Assimiliation in Schools: A Theoretical and Practical Framework

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## Abstract

Information Technology (IT) assimilation constitutes a big challenge for schools. An IT assimilation framework (ITAF) in schools is suggested. The main elements in each of its components are presented and the framework's potential is indicated as a tool for effective and successful implementation, operation and usage of IT in schools. An integrated example and guidelines for school employees' preparation programs conclude our discussion.

Keyword Codes: J.1; K.6.1; H.4.2
Keywords: Administrative Data Processing, Education; Management of Computing and Information Systems, Project and people Management; Information Systems Applications, MIS.

## 1. INTRODUCTION

To our best knowledge, the issue of IT assimilation into school administration has not received, so far, a thorough and focused discussion in the literature. The absence of such a discussion is particularly felt due to the rapid computerization process strived after by and taking place in schools. School management information systems (MISs) are being designed and implemented [1] to provide educational administrators with new tools to support them in a variety of activities like: grade and attendance reporting; placement in classes; teachers' allocation to classes; construction of school time-tables and examination schedules; assignment and disbursement of resources; follow-up on the implementation of decisions; analysis of teacher and school achievements, etc. At the same time, automated office tools (e.g., electronic mail, electronic archives, spreadsheets, automatic follow-up of decisions, electronic appointment books, automatic dialing, desk-top publishing) are rapidly becoming routine. The school, as a small organization and lacking IT professionals is not well prepared to cope with the technological change [2].

IT's introduction into the traditional school structure has run into difficulties [3,4] and even dangers [5]. Situations where computers installed into traditional school structures are not fully and effectively used are frequently reported [6]. As a result IT's use and effectiveness are limited, and administrators are frustrated [7, p. 284].

The same is true for school districts. A survey showed that the number of management applications of IT, and the dependency upon it for conduct of business affairs in school districts are on the increase, but it was also found "(a) that most districts have too much, 'data' and too little 'information', (b) that requests for information outstrip the capacities of existing systems, and (c) that requests for data or information often fall outside existing categories or filing systems" [8 p.198]. Though these findings come from the end of the 80's, the professional literature does not seem to indicate significant changes during the recent years.

The absence of an overall, integrated approach for IT assimilation in schools is, very often, a dominant factor in this failure, resulting also in (or perhaps from ?) the faulty perception that IT introduction is merely the purchase and installation of hardware and software, accompanied by some introductory training. Rejecting this perception, this paper suggests an IT assimilation framework (ITAF) for schools. It is reasonable to assume that ITAF will significantly contribute to a more successful IT introduction and usage in schools and educational authorities.

## 2. THE IT ASSIMILATION FRAMEWORK

### 2.1. Theoretical foundations

The incorporation of IT into the day-to-day activity of schools is not merely a technical-oriented issue, but rather has a strong and overall impact on the entire school structure and dynamics. ITAF should, therefore, reflect this point of view. Current systems approach, which is also a . "new and emerging approach in educational administration as from the 1970s" [9, p.128], provides the theoretical foundations for ITAF. The systems approach typifies Kast and Rosenzweig's [10] view of organizations. According to them the school, like any organization, is composed of five major, partly overlapping subsystems: managerial, structural, psychosocial, goals and values, and technical. Introducing a change in one of them would lead to changes in the other four. These five subsystems provide the foundation for ITAF. Ahead we shall present an overall, integrated approach for IT assimilation in schools based on these theoretical foundations.

Due to the complexity and variety of elements in each of the five ITAF components, the examples under each of the components do not attempt to encompass all ITAF issues.

### 2.2 ITAF subsystems

#### 2.2.1 The managerial subsystem

As in any organization, the main elements of the school's managerial subsystem are: goal setting, planning, organizing, assembling resources, staffing, directing, coordinating, budgeting, evaluating, implementing and controlling [10, p.115]. As classified in the above theoretical foundations, each of these elements is affected by IT introduction, and assimilation activities should relate to what implications IT introduction would have on each of them and to the training needed to cope with them. For example: school's computerization policy formulation; specifying information requirements; IT assimilation master-plan preparation; IT introduction and performance evaluation; re-definition of resources allocation; staffing - recruiting of IT professionals or changing existing roles for this purpose; redefining school's computerized control (and supervision) procedures (i.e. looser versus tighter school coupling; consideration of "quality control" regulation in schools), etc.

### 2.2.2 The structural subsystem

IT introduction may result in the addition of new roles in the school (e.g. the school computer administrator) as well as in far-reaching implications on school's work flow, authority, information flow, procedures and rules. Within the school environment assimilation activities should therefore relate to issues such as changes in the school's formal organizational structure; necessary changes in the information flow within the school and between the school and its external environment; effects on interrelations between school employees; etc.

### 2.2.3 The psychosocial subsystem

The main elements of the school's psychosocial subsystem are: human resources, attitudes, perceptions, motivation, group dynamics, leadership, communication and interpersonal relations [10, p. 114-15]. IT assimilation results in the school's need to confront a cluster of psychosocial issues associated with IT assimilation and aggravated by computer illiteracy of the school's instructional and administrative staff [11].

Examples of IT effects on the components of this subsystem's could be the need to identify potential barriers to IT introduction into school, or the development of standards for professional development programs for school administrators and teachers (see paragraph 4). Changes in relationships between school employees (teacher-teacher, teacher-counselor, counselor-principal, etc.) should be, if possible, forecasted and frequently investigated. Appropriate steps, whenever necessary, to introduce changes in communication patterns within the school and between the school and its external environment, should be taken.

### 2.2.4 The goals and values subsystem

The main elements of the school's goals and values subsystem are: culture, philosophy, overall goals, group goals and individual goals [10, p.114]. Each of these elements is effected by IT introduction. Examples of required activities within this subsystem are the formulation of a new "school philosophy" for the computerized school; the effort to define IT introduction goals for administrators and teachers; the detection of changes occurring in the school's interrelations with its environment; ethical use of IT for educational purposes; dealing with legal aspects of IT (e.g. security and data confidentiality in school), and using information provided by IT to define school goals in a less ambiguous way.

### 2.2.5 The technical subsystem

The school's technical subsystem is shaped by the following elements: knowledge, techniques, facilities and equipment [10, p.114]. Each of these elements should be adapted selectively to suit the special requirements of the school, and to make appropriate use of technology - technology "as a process and not as a product" [12]. Examples of appropriate activities within this subsystem are the preparation of computer sites; purchase, introduction, operation and maintenance of hardware and software; adaptation of new knowledge areas and techniques necessary for this purpose.

## 3. AN EXAMPLE

In order to illustrate an integrated, overall IT assimilation process, the introduction of a management information system (MIS) into schools will serve as an example. Due to the variety of elements, the complexity and scope of each of the five ITAF subsystems, the following is just a partial example that does not attempt to cover all ITAF issues.

The **technical** subsystem is significantly changed: Information requirements (defined by the managerial subsystem) have to be translated into IT specifications, e.g. development or purchase of MIS software, choice and purchase of suitable hardware, communications, operating system and office automation tools and their installation in a (sometimes new) computer site and on employees' desks all over the school.

The **structural** subsystem is immediately affected by the changes in the technical subsystem. The addition of a new role - that of the school computer administrator - will result in a change in the school's formal organizational structure. The establishment of a central integrated database replacing the manual archives and filing cabinets will result in changes in existing roles and information flow. For example, the computer on the principal's/counselor's/etc. desk, gives him or her, direct access to the school's integrated database, thus minimizing his or her dependency on information middlemen. The information retrieved is more updated and broader than before IT introduction. New statistical and comparative analyses are available.

The **psychosocial** subsystem is affected as well. Some school employees might resist the change while others may be enthusiastic, with a potential of conflict between the two groups. Recruitment of new staff, necessitating IT-oriented qualifications for new and/or existing roles might be necessary. School employees development programs should be carried out (see paragraph 4).

The **goals and values** subsystem undergoes change as well. Administrators and teachers have to understand that computers do not transform students into numbers and that IT in an additional administrative (and instructional) tool for achieving school administrative and instructional goals, for example: identification of students needing special educational care, excelling/underachieving students, and so on. Criteria on ethical use of information and for data security and confidentially, should be formulated and strictly enforced on all school employees.

IT introduction into the **managerial** system provides school employees with information and tools hitherto unavailable. These may assist them in decision making, management and follow up in their areas of responsibility, as mentioned under 2.2.1. The actual changes occurring in school management should be thoroughly researched. The principal should initiate, manage and supervise the above mentioned changes in the four other subsystems. S/He and other school employees should use MIS as an aggressive educational leadership tool [5, 13], enabling them to perform their various administrative and pedagogical tasks. For this purpose, the principal and other school employees should acquire (through adequate preparation programs) new knowledge areas relating to MIS assimilation, operation and usage. Equipped with this new knowledge the principal should be responsible for a precise definition of the major objectives of MIS introduction for administrative and instructional purposes. S/He should formulate policy guidelines and an effective school MIS strategy within a master-plan for MIS introduction, including a clear definition of the principal's information needs and those of all of the school employees.

The principal should control MIS introduction and be capable of managing school's MIS. The principal (and other school employees) should be cognizant that MIS, as a managerial tool, is a means and not an end in itself, and that it should primarily serve the pedagogical needs of school.

## 4. SCHOOL EMPLOYEE PREPARATION

Proper school employee preparation programs are a pre-requisite for IT's successful assimilation. ITAF should become an integral part of the curriculum of universities and other institutions preparing school administrators, so that the latter will learn to understand ITAF's objectives, advantages, limitations and its day to day operation; IT's possible applications; IT's potential uses as an aggressive educational leadership tool and as a pro-active management tool; IT's potential for school administration (and instruction) and as leadership enhancing professional productivity tool. Principals should also be trained to prepare contingency frameworks for IT assimilation in their specific school situations, and to understand the organizational contexts for a successful IT assimilation.

Specific preparation programs should be prepared for:

a) principals and school management staff.
b) school computer administrators.
c) administrative staff.
d) teaching staff.
e) assistance staff (e.g. counselors, psychologists).

Training activity should take place prior to IT implementation and subsequently on an on-going basis familiarize staff with hardware and software changes and recent developments. Proper preparation is a pre-requisite for overcoming school employees possible resistance to change (see paragraph 3).

## 5. CONCLUSION

The computerized school in which administrators and teachers will be working in the late 1990's will be far different from today's school. One of the main conclusions of this paper is that IT introduction affects the entire spectrum of school activities in its five main separate yet interrelating subsystems: the managerial, structural, psychosocial, goals and values and technical. The ITAF suggested in this paper matches each of these subsystems. A master plan for an efficient, reliable and controlled IT assimilation in school is very much recommended. ITAF is vital for successful IT assimilation in school administration: Without it, very often, IT is introduced in ignorance which either results in failure, or even worse, creates the danger of transforming school into an "industrial" organization. It is hoped that this paper will raise awareness and recognition of the importance and potential of ITAF for IT assimilation in schools.

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# 3

## Computer assisted school administration and management: Where are we and where should we go?

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### Abstract

In this paper the international state of the art of computer-assisted school administration and management (CASA) is presented. This is done by analyzing the developmental stages CASA has gone through, available school administrative computer applications, factors determining school information system implementation and the impact of system use. Finally, some reflections on the future of CASA are presented.

Keywords Codes: K.3.1, K.4.3, K.6.0
Keywords: Computer Uses in Education; Organizational Impacts; Management of Computing and Information Systems, General

## 1. INTRODUCTION

About two and a half year ago the Journal of Research on Computing in Education published a special issue on CASA [1], which was designed to document, on an international level, the status of computer usage in support of school administration.

One important reason for the special issue concerned the limited attention that CASA receives in the literature which is in strong contrast with the wide utilization of computer technology for the operation and management of schools. Until the literature had paid no attention to issues such as shortcomings of the available software, successful strategies for information system design, development and implementation, and the impact of the use of computers on the efficiency and effectiveness of administrative and management activities. Therefore, authors from Australia, England, Hong Kong, Israel, Mexico, the Netherlands and the United States [2] portrayed the developments and state of the art regarding CASA in their country. The last article of the special issue summarized some general developments and problems and pointed to future needs and required problem solving strategies.

The contents of the concluding article of the special issue, in combination with the results of additional empirical research, form the basis for this paper.

## 2. DEVELOPMENTAL STAGES

The country-specific articles of the special issue led to Table 1.

Table 1
Time-frame for each stage of CASA development in seven countries (based on 1991 data).

| | *initiation* | *expansion* | *integration* |
|---|---|---|---|
| Hong Kong | end 70s | early 80s | not yet |
| Australia | early 80s | mid 80s | '85 |
| Great Britain | '78 | '83 | '83 |
| Israel | till '85 | '85 | not yet |
| USA | end 60s | '70s | '80s |
| Netherlands | mid 70s | end 70s | '85 |
| Mexico | '58-70 | 70s | not yet |

Some interesting general trends are certainly emerging, but one must recognize that large differences may exist between schools within a country. So, if an author observes a country as having attained a certain level of CASA, this is likely to mean that only some of the schools are at that level, in most cases only those that are leading in CASA.

Basically the same *'initiation picture'* is observed in all countries. Teachers in the science subjects started to create the first school administrative software in an enthusiastic, but amateurish way. Some years later, software vendors entered this market producing their own software or adapting existing software to more professional standards.

The differences with regard to when countries entered the various CASA stages are striking. The U.S.A. clearly took a pioneering role in this area; the first applications were initiated there in the 1960s when the first school business applications (e.g., finance and pay-roll) were implemented. It took many of the other countries 15 to 20 years more to reach the same level of school administrative computing. Mexico has been in the initiation stage since the 1960s, but only for educational administrative computing at the central government level. Thus, administrative computing at the school level in Mexico has still to embark on the first developmental stage.

However, despite the differences between countries, in most, with the exception of Australia, initial school administrative computer applications had been developed by the end of the 1970s. Subseqently, during the *expansion* stage new applications were rapidly produced in these nations. The expansion stage occurred in the 1970s in the U.S.A. and the Netherlands, and in the 1980s elsewhere.

The *integration* phase can, succinctly stated, be characterized by 'integrated modules' and 'the production of management information' (such information was then considered valuable for the first time). By the mid-1980s four countries had progressed to the integration stage (Australia, Great Britain, the U.S.A., and the Netherlands). Israel, Hong Kong and Mexico have not yet reached that level of CASA; they are still in the expansion stage in which several loose, non-integrated clerical and administrative applications are being used. Therefore, computer-assisted management support may be limited in those countries.

During the *stabilization* stage the full potential of computer assistance gets accomplished to some extent, and attention therefore is directed to system maintenance and refinement. One gets the impression that none of the countries has truly reached this CASA stage because a number of applications (especially management subsystems) are still not available and full utilization of the potential of information technology is not a reality. For that reason the stabilization stage is not included in Table 1. Some countries, however, expect to enter the stabilization stage in the near future.

An interesting observation concerning the evolution of CASA is that a country like Australia, which until recently was lagging behind, has changed this situation dramatically in just a few years. Certainly with regard to the broad scale of CASA implementation Australia at this moment is one of the leading CASA nations. Since the mid-1980s, serious statewide (New South Wales) attention has been given to CASA through evaluating existing software, producing a new high-quality school information system, and supporting schools with system implementation. By 1992 more than 2200 schools will be using this standardized system! The Australian experience implies that if a nation decides to direct serious attention to CASA and if it is able and willing to commit the required resources, it is possible to change the state of practice dramatically in a few years.

Not only 'down under', but also in other countries a special project initiated by national or state government, or by a special project group, has provided the stimulus to enter a higher developmental stage. Israel had its PMIS project, Hong Kong the HKSAS, Great Britain the Local Management of Schools initiative, Holland its SCHOLIS project. In each case these projects have served to lift CASA to a higher level because they were directed toward the production of better school information systems and also stimulated vendors of other software packages to improve their products. If initiatives like these occur in a country, it is likely that the quality of CASA systems will evolve very much; on the other hand, if they do not occur then progress may be much slower.

The experience in Mexico shows how the lack of capable professionals, of finance and of a technical infrastructure for electronic data communication can limit the evolution of CASA. Technology can have a large potential, but when the professional expertise for the development of high-quality systems is not available, theoretically possible systems will not be realized.

## 3. AVAILABLE APPLICATIONS AND THEIR USE

It is difficult to judge accurately which applications have been realized, since the names of the applications in fact only tell us that software has been developed that provides support with activities in certain areas (e.g., finance, personnel, timetabling). What specific activities are supported and how this is done remains obscure. Nevertheless, the information that is presented demonstrates that some countries have progressed much further than others with respect to the number of applications developed.

In several countries a considerable number of registrational applications has been developed (e.g., in Australia, Great Britain, the USA and the Netherlands), but software modules that are directed specifically to the support of school managers (e.g., by providing management information or solving complex allocation tasks) are the Cinderella of the available applications.

The basic structure of a school information system limits or defines the extent of management assistance available. As modern tools such as relational database management systems (RDBMS) and query languages become available, high levels of management support become possible; the query language in combination with a RDBMS enables the definition of, and response to, questions in which school managers are interested.

The international IEA study concerning the use of computers in education [3] showed that CASA is less intensive in primary schools than in secondary schools. This might be because primary schools are less complicated with regard to timetables, data about financial matters, teaching staff, etc. However, this does not explain why about 50% of primary schools do not use word-processing. In general, it seems that although a large number of schools make use of the computer for at least some school administrative purposes, with the exception of word-processing, the majority of primary schools do not use applications like teacher registration, student registration, timetable construction, financial registration and library records.

The number of secondary schools that do not use administrative applications either is still considerable; student data and word-processing applications are found in the majority of secondary schools, but for almost all of the other applications 50% to 80% of the schools do not use them at all.

## 4. FACTORS DETERMINING SYSTEM USE AND IMPACT

In the lead article of the special issue of JRCE [2] the following model for the implementation of computer-assisted school information systems was presented.

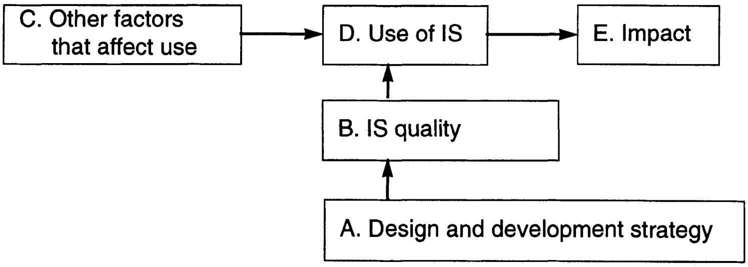
C. Other factors that affect use
D. Use of IS
E. Impact
B. IS quality
A. Design and development strategy

Figure 1: The relations between design, use and effects of ISs.

The degree and way of use of the information system (IS) is supposed to be determined by information system quality characteristics (which are expected to be influenced by the chosen design strategy) as well as by other factors like the nature of the implementation process and of the school organization in which the IS is implemented. Effects of system use are supposed to be a function of the intensity with which, and the way in which, an information system is used.

The information in the country-specific articles of the special issue generally supports the framework. However, it should be stressed that there proves to be little empirical research regarding the implementation and impact of SISs, and therefore clear understanding of the relationships between the variable groups is lacking. While the authors of the country-specific articles typically provided an opinion based on their own experience with CASA projects, it is evident that empirical studies on the framework are needed.

Each of the variable groups in the framework is discussed below, on the basis of the observations of the authors of the country-specific articles.

### 4.1 The characteristics of the design strategy

In most of the countries an evolution of the strategy used to design SISs can be identified. This strategy includes the automation goals, the way in which system analysis and definition was carried out, and how the standardization/flexibility problem (to develop an IS that is standardized and flexible enough to be used in large groups of schools) was addressed. Table 2 summarizes this development process.

Table 2
The evolution of design strategies.

| *designers* | *goals* | *approach for analysis + definition* | *standardization/ flexibility* |
|---|---|---|---|
| teachers | efficiency | - application directed<br>- expert<br>- decentralized | - tailor-made |
| software vendors | efficiency | - more integration<br>- expert<br>- central | - standardization |
| special projects | effectiveness | - fundamental<br>- participative<br>- central | - compromise |

During the initiation and expansion stages teachers developed school administrative computer applications with the goal of improving the efficiency of school office activities.

The strategy used in the analysis of the school organization and the design of computer applications was not very professional, which was due in part to the fact that activities like these were new and knowledge concerning the development of SISs was limited everywhere. The strategy might be labeled 'first things first'. A teacher-designer would observe a valuable opportunity for using the computer (mostly in the area of pupil registration), subsequently started to analyze these school activities and developed software that could assist there. The approach was application-directed: one or two independent applications would be identified, then another one, after that yet another one, etcetera. The teachers who pioneered this were the experts in their schools, and their power and autonomy were considerable. Since the applications were developed by teachers for their own schools, the software was developed in a decentralized way. As a result SISs were tailor-made for the school in which they were developed. Therefore, these were neither generalized systems nor very flexible.

After these pioneering activities software vendors began to enter the CASA-arena. Just like the pioneer teachers before them their design goal was to increase the efficiency of registrational activities.

System analysis often remained limited to a few schools, and subsequently, the IS was adapted on the basis of experience of the other schools that were using it. The strategy that was followed can be characterized as more integrated: not purely directed toward developing a single application, but giving some consideration to relations among several applications. Nevertheless, complete integration was a distant goal.

Just as in the case of teachers-as-designers the vendor software developer played the expert role and user-participation was limited. Although designers of course listened to users, software specialists to a great extent determined themselves what the software would look like. An important difference between vendors and teacher software developers is that the former do not develop SISs for only one school. In fact they try to develop a SIS that can be used in as many schools as possible. This has implications for the system development approach and the way in the which the standardization/flexibility problem is handled.

As a result of the centralized approach, standardized systems are created for many schools, which means that schools have to adapt themselves to the characteristics of these systems. As discussed before, this may cause problems for schools.

The third group of SIS designers is formed by those who initiate a project that aim to product a new generation of SISs. A central feature of these projects is that they strive for better systems, after experience has been gained in the first two stages of CASA. These designers consider school effectiveness as an important goal of automation, in addition to school efficiency. It becomes clear that types of support such as management assistance and computer-assisted data communication within the school and between schools and other institutions can be achieved through computer use. Thus, the goal is to realize in a systematic way all possible useful forms of computer support.

To realize this goal, a fundamental design strategy [4] should be chosen in which designers are aware that the first step is to draw a picture of the entire school in terms of information flow and information demands. Once this picture is available and when the relations among information flows are clear, it then becomes possible to design the architecture of the entire system, resulting in an information system framework. Subsequently, individual modules from the SIS-framework are developed in a stepwise manner.

This group of designers is aware of the importance of user participation and extensively involves users in system design. For this reason the role of computer science experts is balanced by the influence of users. These systems are created centrally and are planned to be used in as many schools as possible.

The fact that system development is not done for only one or a limited number of schools, but centrally, for a large number of them, implies that a standard system is produced. Fung [5] observed that standardization is required with central SIS-development because of the high costs of system design, development, user support, and system maintenance.

While schools will not receive tailor-made SISs, it is tried wherever possible to build flexibility into their IS. Through this a compromise between standardization and flexibility is achieved. The modular structure of the SIS enables schools to choose and use only those modules they need, and options within modules are used to create additional flexibility. Use of modern software tools (RDBMS, query languages) also provides flexibility, since every user can potentially retrieve all information he needs.

Although the fundamental approach to system design can be observed in a number of countries it is not yet widespread, the majority of countries having not yet achieved this level of system development. Nevertheless, if a country wants to develop a CASA capability, it should start with the fundamental, participative and centralized approach. The cost and effort invested will rapidly return the investment, because the system developed is likely to result in the desired improvement of school efficiency and effectiveness.

### 4.2 Information system quality

One of the most important prerequisites for successful implementation of school information systems is, of course, a high-quality SIS. In none of the countries the quality of the available SISs has been systematically studied. As a result, it is not clear how and to what degree the system features may have influenced then implementation. This is regrettable since insight in the variables that determine SIS-quality can help to create better quality systems. What probably happens now -in the best case- is that a SIS is developed, implemented and subsequently adapted on the basis of user feedback, and this process continues until users 'feel OK'. However, this does not necessarily mean that they are fully satisfied or that they use the system to its full potential.

Some authors stated that the ideal software (user-friendly, reliable, offering strong support to users, etc.) still was not available in their countries. Probably this is also true for other countries, because producing high-quality software requires considerable time, for thorough analysis and design, for carefully introducing the systems into schools, and for systematically collecting user feedback to maintain and enhance software. In most countries insufficient time has been invested in these activities. Nevertheless, IS-quality gradually increases as a result of improved system analysis and definition, software development tools (RDBMS, software generation tools, data dictionaries), and user feedback.

### 4.3 Other factors that influence implementation: Features of implementation processes and school organizations

'People variables' prove to be crucial anywhere. Motivation for, and attitude about, the innovation were mentioned very frequently, as was the extent to which future users can influence the process of development and implementation.

On the basis of seven case studies in pioneer schools Visscher [6] concluded that the innovation process first raises a variety of problems, among other things as a result of vague goals and inadequate planning. The limited resources may cause those who are responsible for implementing the innovation to be overloaded. After some time, however, most of the problems seem to get solved and school (office) life returns to routine.

Many authors stress that careful management of the innovation process is essential. The procedural side of the innovation process is crucial: It is important to establish clear innovation goals and a realistic innovation pace. Schools need time to learn to appreciate and assimilate an application. A gradual, 'stepping stone' implementation of a modular

SIS therefore is viewed as the best way to innovate in this field.

Bird [7] and Fung [5] stressed that when a project champion encourages the innovation, the chances of successful implementation are much greater; the same applies to the extent to which school management encourages and supports the innovation.

Bird [7] pleas for school-based project teams that consist of a number of staff members; knowledge about CASA then is dispersed among staff, which means that if one of them leaves the school this will not cause big problems for the continuation of CASA within the school.

The introduction of SISs has made it clear that the training of users is essential and that this usually receives far too little attention. Training often proves to be too technical, or else it does not focus on how the system is intended to support users in their various management responsibilities. User-training is important to teach users how to use hardware and software, as well as data produced by an IS. The latter training is connected to questions like 'What do data mean?' and 'How can one use reports produced to make decisions?". Although answers to this type of questions are very important, they frequently receive very little attention.

Some authors noted that schools that operated well before computer introduction also were more successful in implementing an innovation. This may suggest that if a school has problems, the introduction of the computer is not likely to solve these problems. In fact it is very probable that the implementation process will exacerbate existing problems.

### 4.4 Degree and way of information system use

An important finding is that SISs in almost all countries are used to support clerical activities. Routine office work that formerly was done manually now is carried out by means of the computer. Support of school management activities, however, is very limited. This may be the result of the fact that in most countries relatively few management applications have been developed, or it might be a consequence of the characteristics of schools and of the way school managers choose to operate. It was already observed that little empirical evidence has been collected on the impact of school organizational factors, and it is unclear as to what extent school managers really are in need of management information and what type of computer support they would like to receive. It might be for instance, that applications that help them solve complex allocation problems (e.g., timetabling) will be used much more extensively than software that provides managers with information that serves as a basis for policy development. Schools often are considered to be 'professional bureaucracies', in which teachers operate very autonomously and policy development and implementation therefore are difficult, especially when teacher autonomy is threatened.

The results of a recent study by Visscher [8] showed that providing a school with a computer-assisted school information system which can generate valuable management information does not mean that school administrators automatically will benefit from this opportunity. Almost all schools studied used the system for daily, routine absenteeism registration activities. Very little use was made of the potential to analyze absenteeism data and look for trends and relations among relevant data elements (e.g., when pupils play truant, which subjects or teachers have greater absenteeism rates).

One plausible reason for this may be that schools need more training to develop their computer-assisted policy-making capacity. Schools that want to use the computer for this purpose, need to be able to:

- decide which information they need for decision-making and would therefore like to retrieve from the system;
- retrieve data by means of a menu or a query language;
- interpret retrieved data in such a way that the resulting information can be used for decision-making;
- use the information to develop, implement and evaluate school policy.

The second and third conditions may be regarded as technical and thus require some training in data retrieval and interpretation. The first and last mentioned skills are probably harder to realize. It has already been indicated that schools in general are not considered strong policy-makers and evaluators and that installing a computer-assisted system will not automatically transform them into either. Evaluating school processes critically, detecting problems and causes (if possible) and trying to design, implement and evaluate remedies, requires organizational development often. This may well be a lengthy procedure and demands energy from schools and from those who support them. It would be interesting to investigate whether it is possible to train schools in the skills that are a prerequisite for computer-supported policy-making and, if so, which training characteristics are the most successful.

### 4.5 System use effects

Very little research has been carried out on the positive and negative effects of SIS-use. Many authors anticipate certain positive effects (e.g., better registration work, better decision-making), but strong empirical evidence for these effects is lacking. None of the authors observes an improvement of the quality of schooling and teaching, or an impact on the school organizational structure as a result of school administrative computing.

In the IEA-study on computer use in education [3] respondents from many countries were asked whether they thought school administrative computer use had led to positive or negative effects. A range of positive effects was strongly perceived to have occurred, including improvement in:

- quality of pupil administration
- information available
- quality of teacher administration
- efficiency of school administration
- other organizational aspects

Other positive effects were perceived less strongly, including improvement in:

- the evaluation of policy effects
- the time needed for absentee registration
- information on pupil achievement
- the allocation of students to groups
- timetable quality
- time needed for timetable construction

Relatively few negative effects were mentioned by respondents and those that were observed were mentioned by very few respondents.

## 5. THE FUTURE OF CASA

Plans for the future of CASA vary. In quite a lot of countries further development of (management) applications is an important goal. Development of sophisticated decision support systems and further integration of databases and educational and administrative computer applications is planned in countries that are very active in the field of CASA. The government is frequently involved in this activity and usually plans a wider implementation of professional SISs in schools.

Establishing local area networks within schools and linking them with other schools, districts and governmental ISs is another frequently mentioned plan, as well as providing schools/users with (more) intensive implementation support.

Should a country desire to utilize information technology for school administrative support, a fundamental approach is recommended:

1. A careful analysis of schools and their environmental interaction, to find out what information is valuable for executing the various organizational activities.
2. Design of information systems at central (state or national) level. Future users should be involved in these design activities so as to explain their potential information system needs. An information system framework (ISF) should be designed, containing a complete definition of all (clerical and management) required capabilities that can be obtained from modern information technology to support the needs of the school.
3. Software should be generated for each ISF-module and the desirable implementation strategy be defined carefully, taking into account:

- the logistic aspects of introducing a SIS into schools: e.g., the prerequisites for data entry, and the adaptation of school procedures;
- the need to train users adequately (information management being an important training topic);
- the need for a project team at school level to back up for the school CASA-expert should he leave. Moreover, a project team can facilitate implementation by motivating users and planning and coordinating the required activities carefully, and
- the capacity of schools to adopt, implement and incorporate an innovation. A gradual 'stepping stone' approach is required; only after a school has incorporated an information system module introducing the next module can be considered.

The role of the government should be an active one from the start, since the market for SISs often is not commercially interesting enough for software vendors. The construction of high quality SISs requires too high an investment in relation to its potential revenues.

Strong governmental support is also of importance for the government itself, since the use of professional ISs can improve the quality of school management, which is especially valuable with regard to the initiatives to devolve competences from central governmental level to school level. As a result schools become more autonomous, and have to develop and evaluate school policy in areas previously under responsibility of the government. School information systems can be a powerful tool for more autonomous schools who need information on which to base their policy-development and evaluation. However, the potential role of these systems should be placed in perspective.

Information use within organizations is complicated. The link between the information collected and the problems faced may be weak. Sometimes information is used to justify decisions already made and information collection is focused on the measurable.

Moreover, managers heavily rely upon verbal, face-to-face information, rather than on formal (e.g., computer-assisted) reporting. They only partly behave like rational, informed problem-solvers. Decision-making is often done over brief periods of time, and getting information rapidly can be more important than getting absolutely right information. That management information must be tangible and address specific problems also puts managers' use of aggregated computer information in perspective. In connection with this Sproull and Zubrow [9] stress the importance of *behaviourally* grounded information systems, consisting of many modes of information collection (including informal modes), sources, (e.g., students, parents, teachers) and varying forms of information use (problem solving, symbol management). Since only part of the required information can be produced by the computer, other ways of data collection and processing, including non-rational ones, should be used as well.

The usage of computerized information systems is also influenced by some organizational features of schools. Schools are nog considered to be very decisive policy-makers. Decisions are often off, or do not solve a particular problem, and the link between decisions and their execution is weak. A school's policy making capacity influences the degree to which it will benefit from computer data. Although SISs certainly can be of importance in policy-making, these organizational characteristics imply that policy-making and -execution will also be difficult in a computerized situation.

A final remark concerns research in the field of CASA. We are in need of systematic, empirical research, not only because of its scientific value but also to be able to improve the practice of school administrative computing. Hopefully, future studies will increase the body of knowledge about this field and enable us to utilize fully the potential of CASA in making school administration and school management more effective.

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# The Use of Task Analysis and User Acceptability Audits in Implementing Information Technology Systems in Schools

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## Abstract

To be effective, new technology must meet the needs of the organisation into which it is installed. These needs may be expressed at different levels in terms of goals, organisational objectives and individual task needs. Any measure of successful implementation must take into account the inter-relation between these factors, rather than treat them individually. If the intended educational benefits are ultimately to be achieved it is imperative that systems adequately meet the business and/or curriculum needs of schools, contribute to effective organisational activity and meet the task and human/social needs of the user.

Research in the industrial and commercial sectors has shown that the success rate of introducing IT systems into organisations could be as low as 20%. This is obviously a worry if such a level of success is transferred to the education sector when the future and careers of so many people is at stake.

This paper summarises work done in trying to develop strategies, derived from evaluation tools developed in the business sector, which can help to measure the organisational needs of schools and contribute to the evaluation of the IT systems through the task analysis and user acceptability audit, which provides data to feed back into implementation to reduce the possibility of failure and rejection by administrators and teachers.

Keyword codes: K3.1; K4.3; K6.1
Keywords: Computer Uses in Education; Organisational Impact; Project and People Management

## 1. INTRODUCTION

One of the consequences of the Education Reform Act of 1988 for England and Wales has been to increase the financial and overall management responsibility of individual schools. The new Act also placed a legal requirement on schools to make available additional information to parents, Governors, Local Education Authorities (LEA's) and the Government Department for Education (DfE). The type and nature of information flow has therefore altered. The internal financial management of schools has, at the same time, become the responsibility of the Governors, managed on a day-to-day basis by the Head teacher.

All these changes have accelerated the need for a full IT management system with the functions of a medium size business system, plus other functions unique to the school environment. However, research on the implementation of IT systems into the operation and management of commercial organisations has shown some disturbing statistics on success rates. Although precise levels of IT implementation success are difficult to obtain, partially due to the lack of initially accepted success criteria at the design stage, a range of research results are reasonably consistent in giving a success rate of about 20%, with a further 40% being marginally successful and 40% being totally written off. Such work has been reported by Eason [1], Plenart [2], the Department of Trade and Industry in the UK [3] and independent research carried out at Loughborough University by Wolfe-Murphy [4] and Ingelby [5]. This wide variety of research sources provides some confidence that the success rates are, in fact, low. Analysis of the research shows that risk of failure is profoundly affected by the following factors:

- Inadequate consideration of organisational and task issues.
- Failure of the supplier to deliver the promised product.
- Mismatch between expectations of user organisation and suppliers provision.
- Inadequate project and commercial management.
- Lack of awareness and experience in user organisations
- Inadequate support during implementation

Successful implementation is characterised by situations where:

- Organisational changes are identified and exploited.
- Gains are easily quantified.
- Requirements are well defined and led by user needs.
- Expectations of the user organisation and suppliers provision are matched.
- There is a sufficient critical mass of users to exploit the potential for enhanced communication.
- Support and training is designed appropriate to user need.

The Audit Commission for England and Wales [6] identified that IT implementation in Local Government suffered many problems because "few authorities have made arrangements in the past to carry out a detailed review of a newly introduced system to ensure that the application met the original specification or that anticipated benefits were actually achieved". They went on to say that "There is little merit in devoting considerable effort to feasibility studies and other evaluation processes if there is no check that the desired objectives have been achieved."

There is little evidence that any of this 'considerable effort to feasibility studies' formed part of the initial implementation of IT in school administration, and historically 'education' has not actively pursued a policy of evaluating educational change. In fact, a compilation of IT development in seven countries carried out by Visscher and Spuck in 1990 [7] came to the conclusion that "the strategy used in the analysis of the school organisation and the design of computer applications was not very professional". Early attempts at IT systems involved the computerisation of specific administrative tasks in isolation, and the systems produced were merely computerised models of the manual system due to the inability of small scale projects to alter organisational structures and practice. This close modelling to the manual systems also ensured user acceptability in the short term due to immediately identified gains and one-one support and training. However, changes to organisational structures must be included as a possible part of an holistic technology based information system, rather than imposing the technology onto present operational systems.

Writers on innovation acceptance theory have also identified problems relating to the personal and organisational aspects of implementing new IT systems. Mackie and Wylie [8], for example, report that "the significant promises of new computer technology ...... are not likely to be realised unless resistance to innovation, and the reasons for it, are recognised and systematic efforts are made to minimise it". There is a further problem that, with a low level of initial awareness, the innovation may have been developed in anticipation of future needs that intended users are not aware of and may not agree with the innovators that a need actually exists.

These factors can all be addressed as components of the User Acceptability Audit tool, used in association with a properly designed Task Analysis to inform the requirements of the proposed software and organisational structures at an early stage of development.

## 2. THE TASK ANALYSIS

According to Kirwan and Ainsworth [9] a Task Analysis is the name given to any process that identifies the various tasks that must be performed by users when they interact with systems. Shepherd [10] describes the task analysis as "trying to make sense of what people do or what they actually do". The approach used for a specific task analysis can vary according to the task being examined, and Kirwan and Ainsworth list 41 different techniques with detail descriptions of 25 of them. Although many methods are closely linked to the study of timings of tasks, this is not of primary concern when using the task analysis to observe the functions carried out to achieve a result in the early stages of describing the requirements of systems being used to support school management. Obviously the time factor is important when considering the replacement computerised system to reduce the risk of rejection.

A methodology described by Shepherd [10] is the Hierarchical Task Analysis (HTA) which he specifically links to the development of computer systems and the associated human-computer interaction. School management is particularly concerned with using information generated by the administration system to support the decision-taking process which ultimately affects the learning environment of the school. The HTA starts by looking at the 'goals',. which in the school would relate to the types of decisions which need to be made, and at any stage there might be a series of sub-goals which all contribute to the decision making process. The HTA allows the processes and information flow which contributes to the management decisions to be analysed and charted so that an overall system can be visualised. There will be many instances when a particular piece of information contributes to more then one management decision and such linkage of information can be considered when looking at the way in which a computerised system can minimise direct user manipulation of such information and how indirect users might get access to relevant information.

It is, however, recognised that the objective collection of data on task performance is not easy, and in case of the school administration and management systems this will probably be carried out using a combination of direct observation, questionnaire and discussion with the 'expert' [see, for example, Diaper, 11]. Analysis of the wider aspects of the information flow and administration, such as the needs of individual departments, will also need to be carried out if a computerised system is going to contribute widely to the increased effectiveness and efficiency of the school.

## 3. THE USER ACCEPTABILITY AUDIT

The utility value of the new technologies is largely determined by their acceptability to the user; the user acceptability audit is an attempt to measure the level of acceptance. At the same time, the audit can be used to identify barriers or promoters to the successful implementation of the IT system. This approach is being developed at the Human Sciences and Advanced Technology Research Unit at Loughborough University [12]. The audit focuses on the user, the task, context variables and the technology tool [13] through the consideration of three core concepts:

Usability - the extent to which systems match user characteristics and the skills for the task concerned.

Functional utility - how well a system fits a set of particular task needs.

User acceptability - how willing users are to use the system in their own organisation.

The acceptability criteria fall into four further categories of task match, ease of use, user support and perceived consequences, the later being used to assess a range of organisational and job related aspects which are affected by the computer system. [for further discussion see, for example 12, 13 and 14].

Each user acceptability audit requires the creation of investigative tools based on these criteria but tailored to be context specific using a combination of objective measures and subjective assessments. The objective measures require an examination of the physical environment, hardware configuration and general performance. Subjective assessments would normally be made using pre-defined questions for a semi-structured interview [15].

## 4. APPLICATION

The task analysis and user acceptability audit can be used in schools to assess the needs of the organisation and help to ensure that any implementation is successful in management and adminstration. Small scale trials of the methodology have been carried out at Loughborough University and the results indicate that, although the systems are not in the failure category, they are in need of attention to ensure long term success. These trials involved both direct users and indirect users of a finance management module of a widely used system; direct users being those who actually operate the system and the indirect users are those in the organisation who use the output from the computer to make management decisions.

The task analysis looked at the financial management module of a widely used system. Data was represented in the form of flow charts, and barriers to the smooth flow and operation of the system were tabulated [16]. Important findings included:

- The flow charting showed that the computer system was virtually a direct mimic of the previous manual systems but required a set sequence of inputs to achieve the rquired function. A manual system is inherently flexible because, for example, the user can always put one ledger on the side to refer to another, or flick from one page or one year to another. This flexibility was completely removed.

- There are both system and organisational problems in the present implementation of the systems. Users identified problems in the area of setting up the budget, ordering, reconciliation, and financial summaries.

- A number of users were re-typing printed information from the system into a spreadsheet in order to 'model' particular scenarios. This should not be necessary for a system properly task oriented towards supporting management decisions.

- The ordering system was very restrictive in its operation.

- Financial printouts were not easy to understand and were not under the control of the users

The task analysis study, although only small scale, complemented findings from the initial attempt at contextualising the user acceptability audit which was trialed in 11 secondary schools. The data was analysed in terms of the user acceptance criteria using simple frequency counts, the intention being to assess the systems success and generate information which would identify specific factors acting as promoters and barriers to successful implementation. It is not possible to include the detail of the questions within this paper [see Wild et al, 13 and Scivier, 15] but the main findings are:

- Ease of Use: The majority of users were generally satisfied with using the system in their work, but specific problems highlighted were printer paper problems, error handling, output, keying and navigation. Error handling and output were the greatest problem areas. It was reported by the users that corrections to data could not be made once data is confirmed and output had to be changed by hand to ensure the accuracy of information. Errors were recorded manually in a book to try to ensure that printouts could always be altered when required. This obviously raises questions about data being accurate and up-to-date. Physical environment caused problems in nearly 50% of cases and compliance with the EEC Directive 90/270/1992 would obviously be a growing issue.

- Task Match: A serious area of concern was that data was not accurate, recent or complete, exacerbated by the error handling problem. These problems related to the difficulty in maintaining data input due to general workload caused by system implementation.

- Support: This includes issues of training, userguides and external support services. Over 50% of users reported problems in learning the system, with some of the problems related directly to the training such as delay in using the system after training, and the trainers lack of knowledge of the direct users tasks. The training was system and technology based rather than user context based. The lack of user and organisational tasks being reflected in the index of the user guides caused further problems when searching for help. The level of resourcing of the external support services was questioned, especially in relation to the planned expansion of the systems.

- Perceived consequences: In a cost-benefit analysis, 3 users assigned an overall rating which indicated that the perceived costs outweighed the benefits of the system. Data across specific aspects of job design, organisational issues and personnel policy indicate that changes in aspects of the direct users job design may particularly increase the risk of system rejection, such as work pace and deadlines and an increase in effort by the direct users to keep up with the system requirements. Better career prospects (the ability to apply for jobs outside education!) and increased power and influence of the direct users were helping to promote the system.

## 5. DISCUSSION

An attempt has been made in these small scale unfunded projects to use evaluation tools developed in the industrial and commercial environment in the context of educational management. The end point of any system must be the way it supports management decisions in both pro-active and re-active situations. The better and up-to-date the data, the more decisions can be pro-active.

The projects have resulted in a series of evaluation questions which differentiate between direct and indirect users and put the criteria of the user acceptability audit into the co of the school situation. The task analysis methodology has been found to contribute furth information which complements the data from the user acceptability audit to determine promoters and barriers to the system success.

The data collected allows us to draw some conclusions about the information technology systems examined in the one authority, but it must be realised that such analysis is not usually directly transferable to other organisations.

- The task analysis demonstrated that in many areas of financial managment, the computer system is being used mainly as an electronic version of the manual paper system, with an inherent lack of flexibility.

- The user acceptability audit highlighted problems which will probably limit long term success, in that the system failed to fully meet task demands, barriers to effective use were identified, there is a risk of inaccuracies in processing and analysing data and risks were compounded by a lack of consideration of some organisational and job design factors.

The Local Education Authority responded positively to the findings of this first attempt at an evaluation methodology for such systems in that they felt that "barriers and promoters has thrown considerable light on the strategy and tactics the LEA needs to adopt to successfully establish the use of computerised information systems in schools" [private communication]. This reinforces the conclusion that the packaged tool based on the user acceptability audit would allow schools to systematically evaluate IT systems supporting their administration and management which would give qualitative and quantitative gains to the school.

Recent discussion with teachers has shown some improvement in that the software providers are listening to the users but one teacher involved with using the system succinctly summarised the present situation when he said of the programs "it seems like a series of good ideas which fail at the last hurdle because they don't match the real life situation in the school" [private communication]. This same teacher also uses Dataease and Lotus 1-2-3 to do some jobs "because the main system is too slow", with the need to duplicate data entry. Manuals are still not indexed on tasks or the needs of indirect users and manuals are always a version behind the software. He reports that the system does not save any time due to poor implementation and support. Any system perceived by the users as a poor system cannot be a successful system. It has, however, been found in commercial organisations that there is sometimes a problem in identifying a poor system because "resourceful employees manage to bypass the new system or to keep the old system operating in parallel to carry out tasks made impossible by the new arrangement. The failure of the new system is often not consciously acknowledged in such cases and it may even be proclaimed an 'official' success, even though its full potential is not being realised" [17]. The questions used during a user acceptability audit need to be sensitive to such problems within the context of the organisation.

In 1991, Visscher [18] pointed out that there has been little attempt to assess the effectiveness of computer systems per se, or to evaluate the effectiveness as part of organisations and that "in short, we are lacking substantial data concerning the impact of school administration computerisation". Further development and more extensive testing of the evaluation tools initially contextualised and trialed at Loughborough University is now required to improve the tools sensitivity and range to provide the required data so that future systems can work from a basis of knowledge of what is really required of systems. Individual institutions can then begin to understand the organisational implications and impact of implementing IT systems from the perspective of a range of direct and indirect users.

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## PART TWO

# Implementation Status – National Reports

# 5

# Managing change in "ITEM"

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## Abstract

It would be very wrong to assume that given the hardware and software, ITEM innovations can be implemented into schools with automatic success. Using information technology in the educational setting is an innovative process which needs managing. This paper addresses the management of the change process.

Keyword Codes: K.3.1; K.6.0; K.6.1
Keywords: Computer Use in Education; Computer and Information Science Education; Project and People Management.

## 1. "ITEM" AS AN EDUCATIONAL INNOVATION

It would be very wrong to assume that given the hardware and software, information technology can be implemented into educational settings with automatic success. Using information technology in educational management, ITEM, irrespective of scope or scale, is an innovative process which needs managing.

ITEM has a broad scope encompassing management activities in course planning and scheduling, in curriculum, in instructional asessment, in resource utilization, and in counselling, just to name a few. The history of ITEM at the school level, however, is not long. Microcomputer technology, which began in the 1970s, became popular at affordable prices for schools only in the 1980s, and ITEM started to appear under different acronyms like SCAMP, SAMS, SIMS, CAA, CASA, etc.

Every educational institution, district, or state possesses some kind of information system, be it manual or computerised, formal and/or informal. Whether the information system is effective or not, however, is another question. In the management of education, what one can input into a system is often a matter of priority, and the challenge to any educational administrator in an organisation has always been the question of how to achieve goals with maximum efficiency, based on the information available. When properly managec ITEM could bring with it a number of benefits: better quality of information; saving of tim and effort; improved decision-making; better communication, and better control and utilization of resources. ITEM aims for effectiveness with higher efficiency.

## 2. A VISION FOR "ITEM"

Four levels or scales of development in ITEM can be discerned: the school/institution level, the district level, the state level, and the global level. ITEM innovations or practices at these four different levels can now be identified in many places around the world. The different presentations at this Working Conference spell this out and it is gratifying to see IFIP taking the lead towards a global ITEM vision.

### 2.1 An integrated approach to "ITEM"

The objectives and designs of ITEM systems vary of course at each different level, but it is important to have a holistic view in any ITEM design. The majority of early designs took a 'task-oriented' approach using the computer as a tool to tackle specific problems. This was, and still is, the situation especially for self-developed software in schools working in isolation. At a higher order, different departments of an organisation would computerise according to their own functions, usually resulting in a non-integrated system. With this 'functional' approach, sharing of information across departmental or administrative boundaries is virtually non-existent or limited, with individual departments keeping masterfiles often containing overlapping data.

To take full advantage of electronic data processing, it is necessary to design a total information system that will serve the whole institution or district and derive optimum outcomes. This integrated approach is comparable to town-planning for a city as opposed to individually designed houses.

Computerised information processing systems are useful because the volume of data they can process is large and the speed is fast. Usually many people are involved in the creation and use of the data. All of these people and all of their needs constitute the total system. 'Synergy' is perhaps the best word to describe the prime objective of a total integrated ITEM system, which demands that a holistic analysis be applied to the information needs. As Schure [1] puts it, this requires "... that there be a systems integration of all the available resource components, with the unique potentialities of every element aligned to produce a more effective system as a whole than any resource used singly."

Difficulties arise, of course, when such an integrated systems approach is put into practice. Due to the large amount of reorganisation and rethinking which must go into its design, it has been rarely implemented. But as more parties step into the popularization phase of ITEM, the cry for integrated systems and standardisation for schools within the same region becomes louder and clearer.

Integration and standardisation must not be equated, however, with conformity. While recognising the need for standardisation with central leadership in ITEM development using the integrated approach, school autonomy must be respected at the same time. Enough flexibility must be allowed for schools to maintain or develop their individual characteristics. Both school users in the periphery and office users at the centre must be able to perceive and enjoy the benefits from a successful ITEM system implemented on a regional level. Neglecting this critical factor will create unnecessary resistance from the system's potential users and may fail the ITEM innovation in the end.

### 2.2 A vision of "ITEM" across levels

In the 1980s computers entered schools to aid in a variety of administrative tasks. The next decade will be time for applying the machine to the level of supporting management. While Lancaster [2] distinguishes the higher level of application using the term 'Management Information Systems' instead of 'Administrative Systems', authors in the USA use the term 'Decision Support Systems' [3]. School administrators in the 1990s will be aided most likely by the computer not only in routine administrative tasks, but also in all steps of the decision-making process, namely: problem identification, prioritising of criteria, data organisation, evaluation of alternatives, choice of an alternative, 'what-if' analysis, and implementation of school plans [3]. Besides management and administration, teachers will probably also be using LANS for curriculum management, assessment, counselling, and the like. These are the two internal senarios at the school level of ITEM.

At the regional level, it is envisaged that schools will be tele-linked to their regional education offices for data communication, to other schools for information exchange, and to universities, examination bodies, or even banks as in the Australian OASIS project [4]. It is not difficult to visualise such a network ascending to the state level and the global level. Technology is advanced enough already to support distributed-data-processing in LANs at schools which can link up to central education departments, as well as to telecommunicate with other schools at the international level such as in the AT&T Learning Circles.

Senge [5] talks about the "learning organization" as the successful organization of the future. Effective schools must also recognise the need to develop as "learning organizations" where learning takes place not just for students, but also for all staff members who are striving for continual development. Such schools within one region, when networked together for sharing and on-going improvement, form a "learning community". Towards this end ITEM has an important role to play across all levels in providing the networking environment for schools to communicate and share their experience, both within regions and globally. This kind of computer-mediated-support for international communication and understanding amongst teachers and students would much promote cross-cultural exchange.

## 3. "ITEM" INNOVATION AS A WHOLE PROCESS

In the broadest sense, any innovation would involve basically two phases: creation and development by a producer, and utilization by the client.

The creation phase is not necessarily sequentially separated from the utilization phase. User participation in evaluating and feeding back for improvement or modification during the development process is valuable in several aspects. The product developed will be of better quality and, what is more important, more likely to be accepted by the users. Besides, commitment generated by the involvement of the users will also much facilitate the change process. The SCHOLIS project in the Netherlands [6], as well as the SAMS project now under way in Hong Kong, both bear this out.

Concisely, the whole process of an educational innovation is the transition from its creation to utilization. During this transition period four subsystems are involved: the innovation subsystem, the producer subsystem, the user subsystem, and the change facilitatc subsystem. Managing change in ITEM refers to the handling of interactions amongst thes four subsystems during the innovation process.

### 3.1 Implementation, or assimilation?

'Implementation' is such a common and crucial term in innovation that any writer on the subject would find it almost impossible to avoid. In general terms, 'implementation' is the phase in the innovation process that follows the 'initiation' phase. The use of the term 'implementation' probably bears a close relation to the choice of the widely used term 'change agent'. Both terms, however, unfortunately carry a misleading implication in the context of educational innovation management, namely that innovation is something that can be implanted into an organisation by some agent. This line of thought is then naturally followed by much concentration on resistance to change and ways of overcoming it. In such a classical perspective, 'change agents' are typically people employed by the management to 'implement' something new (and probably unwelcome) into the organisation.

In contrast to classical theories of change, current perspectives on 'change' simultaneously focus on five major areas: (1) change and excellence; (2) change as a learning process; (3) change and people; (4) change and culture, and (5) change and leadership [13]. A people-oriented approach appears to be more promising in managing innovations. With a phenomenological approach that emphasises meanings of the innovation to the actors concerned [7], there is a better chance of success. The primary role of a change facilitator system is to help people to 'learn through' the change process.

The literature shows that educational innovations often fail because they lack proper attention to implementation [8, 9, 10, 11]. The case of Cambire School is a classical example [12]. In the writer's view, lack of attention to implementation is only part of the story; lack of an understanding of 'how' is also a problem. In this regard, it is suggested here that the term 'implementation' is better replaced by the term 'assimilation' in describing the phase that follows initiation in the process of an innovation. Assimilation spells out more clearly the concept of an innovation being absorbed into a system, with a change facilitator system catalysing the process, rather than the traditional view of an innovation being implemented into an organization or a system by a change agent.

## 4. CASE EXPERIENCE WITH THE "SIX-A" MODEL

The Six-A process model for innovation was developed in a study of a regional ITEM case in London in 1986, followed by four school cases in Hong Kong [13]. Some major findings from these ITEM case-studies which form the core elements in the model are listed below:

1. Lack of ownership in, and commitment for success leads to participants' retreat when faced with problems.
2. Adaptation on the part of the organization and its people is unavoidable.
3. Innovation provides a learning experience for the participants.
4. A learning attitude is needed from participants to make it successful.
5. Training and support are crucial elements for successful assimilation.
6. Timely on-the-job training for ITEM is more effective than one-shot pre-service training; untimely training is a waste of resources.
7. "Theory-demonstration-practice-feedback" is a practical and successful training strategy for ITEM.
8. ITEM system-supervisors need problem-solving skills.
9. Understanding of the overall architecture of an ITEM system by the system operators will help to avoid major operation errors and thus increases the chance of success.

To be of value to practitioners a model has to be unavoidably prescriptive in a sense, providing a kind of reference guide for the change facilitator system to follow in the process of helping the user assimilate successfully the innovation system.

The main concern in this model is the utilization by individual schools of an ITEM innovation system created and developed externally, with a change facilitator system (either internal or external) managing the process. To avoid complications in discussing the model, the ideal situation of user-participation during the creation phase of the innovation is presently left out. The whole process of an innovation is a non-linear one and consists of re-cycling loops channelling through six broad stages as shown in Figure 1: (1) Awareness, (2) Attitude Formation, (3) Adoption, (4) Adaptation, (5) Action, and (6) Application.

These six "A" stages are in fact interrelated and overlapping, and can be grouped roughly into three main phases: the first being the initiation phase, including awareness, attitude formation, and adoption; the second being the assimilation phase, including adaptation and action, the third being the institutionalisation phase, including action and application. The cybernetic loops among the different stages indicate that these stages, although shown as discrete and sequential, are in fact 'interfering' with one another. For instance, trialing of an innovation will bring awareness and understanding about the innovation to a different level compared to that at the start. Different attitudes will also be formed as a result of trial which might affect decisions for subsequent actions.

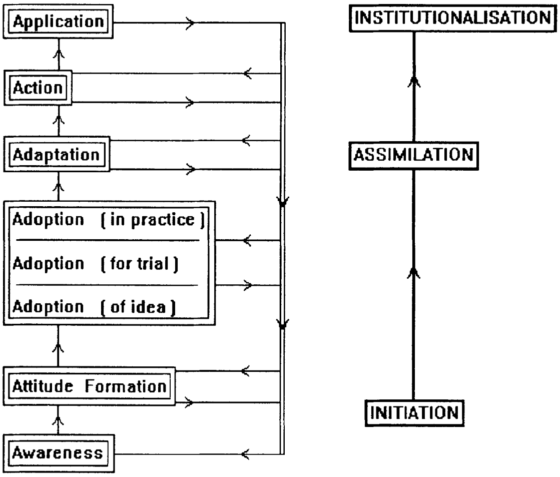

Figure 1. The Six-A process model

### 4.1 The initiation phase

The initiation phase is the transition from the state of knowing that an innovation exists to the state of making a decision of adoption (or rejection). During the initiation phase, the change facilitator should be working in a cyclic process involving awareness and attitudinal changes of actors participating in the innovation. The key feature of this phase is that it follows the "action approach" [14] or the "phenomenological approach" [7]. The meaning of the innovation to the actors concerned, e.g., teachers and clerical staff in the case of a school innovation, is the working target of the change facilitator system.

To get to the stage of decision for adoption is the primary task before anything else can follow. In this regard, a change facilitator can consider taking the following strategy:

Step 1: Defining the 'Relevant System in Focus' - RSF.
Step 2: Searching and communicating information to raise level of awareness of RSF about the innovation.
Step 3: Building common grounds of worth for the RSF.

Even for innovations at the individual institutional level, the user system consists often of a large number of subsystems. It is impractical for a change facilitator to attempt to manage the entire user system as a single entity during the change process. Instead, it is more practical to define a span of focus at a certain time for a certain situation (or phase) during the change process. In other words, the change facilitator with a 'dynamic systems view' is situational in defining the system boundary with relevance to the objective(s) at different phases. People identified as key persons at different stages form the 'Relevant System in Focus' (RSF), i.e., the 'working system' isolated for attention by the change facilitator.

Any innovation will carry different meanings to different user subsystems. Dalin [15] has pointed out that whether an innovation is beneficial or not depends on the answer to the question 'to whom?'. It is argued that successful assimilation requires that relevant subsystems see some worth of the innovation from their standpoint at this initiation phase of the change process. The major task of the change facilitator at this stage is to help merge the initial incongruent sets of goals brought into the user system by various actors, or make overlaps amongst them as much as possible.

**RSF with Incongruent Needs/Purposes of Representative Actors** --------------> **RSF with Overlapping Needs/Purposes of Representative Actors**

Figure 2. Merging of innovation goals

The term awareness used in this context includes information, knowledge, and understanding of the innovation system on the part of the RSF. Different levels of awareness will lead to different attitudes of the actors concerned, subsequently leading to adoption or rejection of the innovation, as well as to different degrees of ownership of it. The role of the change facilitator system during the initiation phase is one of transmitting knowledge, raising concern, and communicating information among the subsystems in the RSF. The provision of information about the innovation system to the participants is particularly important at this stage. Hurst [10] suggests that information about the innovation system to be communicated would include: relevance or desirability, effectiveness or reliability, feasibility, efficiency, trialability, and adaptability.

During the initiation phase, it can be said that the bias or concentration of the change facilitator system is more on knowledge than skills and support. For the assimilation phase, however, the emphasis would be on skills training and support rather than on basic knowledge about the innovation system.

The stage of adoption marks vaguely the beginning of the assimilation phase. For major changes, it is simply sensible and natural to assimilate the new 'thing' by adopting on a trial basis before adopting for real practice. Thus adoption of an innovation may be sub-divided into three levels:

(1) the lowest level (level 1) is the adoption of an idea about a certain innovation, with a decision to search for more information, knowledge, and understanding for further consideration,

(2) level 2 is the adoption of the innovation on trial and marks the beginning of the assimilation phase,

(3) level 3 is the adoption of the innovation in practice -- with the gaining of enough confidence, knowledge and skill, the innovation is put into action in real practice.

For large and complex innovations, adoption for practice is usually preceded by pilots or trials. This is a more secure way to step into the unknown without risking too much. In case the impact of the innovation on the user system is too undesirable or if the adaptation is too costly, the user system can still revert to its original state.

## 4.2 The assimilation phase

The assimilation phase includes adaptation and action by the user system. It is immaterial whether adaptation precedes action, or the reverse. Assimilation is a cycle of events after the user system has adopted the innovation for trialing. It is in essence a phase of experimentation for the user system. When the innovation is used in the real life situation within the organisation, reactions or feedbacks from different subsystems within the organisation will lead to two kinds of adaptation possible:

(1) adapting the innovation to meet user system requirements, i.e., tailoring or modifying the innovation system to meet the organisation's need, and

(2) adaptation on the part of the user system to suit the innovation system, i.e., modifying existing subsystems within the organisation (such as structures, tasks, habits, etc.) to achieve compatibility with the innovation system.

These two kinds of adaptation are not mutually exclusive and often both are required together. In other words, effort is required to manage the relationship between the target of change and the other sub-systems of an organisation.

It is worth mentioning perhaps that feedbacks during the assimilation phase are not limited only to the adaptations and actions taken. In effect the degree of awareness and attitudes of people in the user system are also unavoidably affected as a result of assimilation. Thus the whole process of innovation is an interrelated one, although a breakdown of it into component stages is required for discussion here.

The role of the change facilitator during this phase of the change is one of training, support, and problem-solving in practice. The prime objective is to help and guide the user system in assimilating the innovation, i.e., in getting accustomed to using the innovation, gaining confidence and achieving with it. With enough experience and learning through action while using the innovation system, the innovation can be fully applied with confidence.

The present author shares the view that commitment of potential innovation users is necessary and that their perception of the overall benefits of changing is essential. This is what the initiation phase in an innovation process is all about. However, it is argued that willingness to change is one thing; whether the potential innovation users are able to do so is another. This last question is exactly what assimilation should address. During the assimilation phase of the innovation process, potential users need to become effective users of the innovation. Training and support for the parties concerned are most crucial to overcome general feelings of insecurity and temporary incompetence during this period of uncertainty.

In school-based innovations, acquisition of technical skills and subsequent transfer to the workplace on the part of school staff is the prime objective of the assimilation phase. In this regard, the theory-demonstration-practice-feedback approach of Joyce & Weil [16] in training teachers to learn a teaching repertoire has much to be borrowed. While recognising that there are quite a number of formulations of training elements, these authors have identified this four-step approach, working in an adequate time frame, to be both necessary to, and adequate for the development of job-related skills in most vocations and professions.

### 4.3 Institutionalisation

With successful initiation and assimilation, people in the user system will be able to master the skills required for the innovation with confidence, gaining the full, intended benefits of the innovation. The innovation will be no longer something new to the organisation, and the application of it will become a matter of routine. In other words, the innovation will have been incorporated as a subsystem into the organisation and thus the assimilation phase reaches a sustained stage. This end state of the innovation process is the stage of application, when the mission of the change facilitator system is accomplished. Institutionalisation is then said to be reached, marking the end of the whole innovation process.

## 5. CONCLUSION

Undertaking an educational innovation is much like an adventure. Time and effort needed on the part of all participants as learners and adventurers are naturally much more than what is required when joining a packaged tour. For a better chance of successful educational innovation, the author is of the opinion that such investments are unavoidable. Ironically that is what makes the journey more rewarding to the committed team members.

The "Six-A" innovation model was developed from the theory that innovation is a learning process and not just an event, as Fullan [7, 17], Beckhard & Harris [18], Turrill [19], and many others have advocated. The author would like to add just one last remark about the learning element during an educational innovation process. While learning to develop the skills to handle an innovation system (for example, operating an ITEM software) is necessary for specific innovations, this alone is limited in scope. What is more important is the simultaneous development in the participants of a capacity for change, and also of their understanding of innovating, i.e., generating a developmental culture in schools, as Reid et al. [20] have said. Once leaders and participants in educational innovations understand and accept that change is a learning process on their part, they are more likely to appreciate subjective attitudes about an innovation; more likely to change their attitudes; more likely to commit their time and effort; more persevering in problem-solving; and thus more likely to keep improving continuously both themselves and their schools.

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# ISE - Information Systems in Education

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## Abstract

In order to cope with the complexity of Information Systems in Education, the Israeli government tackled the issue three levels on horizontally and vertically. The government established an information system on the head-quarter level, district and school level. Each one of them deals with the appropriate type of information according to the functional level.

The educational system is a complex system in which all levels must cope with the decision-making process. Therefore, information - which is a crucial resource in any system - is of supreme importance to the educational system.

Keyword Codes: H.4.2; K.3.1; K.4.1
Keywords: Information Systems; types of systems; Computers uses in Education; Public Policy Issues

## 1. THE ISSUE

Every organization requires complete, comprehensive up-to-date information. The information created in the organization and passing through it is varied and extensive, and is transferred among many systems running on a tight schedule.

As result inaccuracy and damage to data integrity may occur; the vast amount of data which is transferred is very difficult to monitor and data can get lost on its way from one subsystem or organization to another. Furthermore data can be understood differently in different systems and environments.

Failure to comply with schedules and deadlines arises because of delay in data-transfer, because the lack of know-how in compiling data into comprehensive, easy to get information.
The main effect is reduced capacity for planning and decision-making and this brings us to a situation where planning based on accurate information is difficult to achieve.

In Israel, this issue takes the following shape: Israel's educational system (like any educational system) is characterized by a large number of users of different types, various use levels and needs government officials, political decision-makers, educational supervisors, school principals, teachers of all levels (some of them with very little knowledge handling information) parents, municipal officials etc. Each one of these uses information on various levels of detail and different extents of usage. A major problem is the "interpretation" each one of the above users gives to any data item. In many cases people relate differently to the same information just because of their diverse understanding of its meaning.

Existing within the system are many subsystems which, while independent in function, have many common and overlapping areas of activity (such as the local authorities and the Ministry of Education). This causes duplication of data which usually leads to misinformation and disagreements. The system is extremely decentralized, with a wide geographical distribution and a large number of users. This affects the level of control and system supervision [1,2].

The advent of the information system, with the data access it provides, has had an immediate effect on every family and person in Israel, with long-term consequences. This can cause immediate critiques and disapprouval which can lead a lot of pressure on the educational system, much more than in other enviroment and systems.

In addition of functioning in a diffuse and large environment under constant pressure ISE in Israel suffers from constant shortages in teaching hours, resources, and budget - while, at the same time being under constant pressure to expand.

The solution is extensive computerization. Present-day advanced computer technologies enable the achievement of the following results:

Supply of all required data while maintaining data integrity, accuracy, and timeliness. Computers now are accessible to every one because of they small size, low cost and larger power. As data can be easily transferred so that users can achieve data integrity utilizing many data resources and compelling it to suit their special needs. Data can be used now as a basis for decision-making on all levels of organization.

As the awareness of information security increases, so does the need for tools and means of protection of data. Consequently there is also a demand for the implementation of the law for the protection of privacy. The new technology enables simultaneous access by many users in different systems. It enables combination of information from many different sources, with the required accessibility. It also enables examination of data and reaching decisions on the basis of decision-supporting ("what-if") techniques under shortage conditions. This brings us towards a more comprehensive ISE.

## 2. THE ISE CONCEPT IN ISRAEL

Information policy in education is derived from the policy of the educational system. The policy of Israel's educational system is based on the "state school" concept. In 1948, the Compulsory Education Law was passed, providing for free, compulsory education between the ages of 6 and 14 and stipulating joint management by the Government and the local authorities. In the 1970s and 1980s, the system tended toward decentralization of management (as a result of decisions made in order to increase efficiency). From the late 1980s until today, the trend toward separation continues. The strengthening of the community and local authority level has led to an increasing degree of autonomy in the schools.

Meanwhile, it was decided to extend free education up to grade 12 (age 18), and the consumption of educational and cultural services at the local level has increased. The guiding principle today is one of locally independent schools (autonomy) on one hand, and communication and integration on the other. Each subsystem within the overall educational system, including each school, is capable of autonomous action toward the collection and handling of data for its own needs.

At the same time, a system of standardization and procedures enables communication with other subsystems and integration of information. A standard manual (SMIS 1992) presents the SMIS framework in acordness with gravement standards. This manual is updated by the goverment form time to time. Thus the overall standardization procedure has been vastly inproved.

The process has, however, not yet been completed. But schools can already "talk" with any other school and/or with any functional unit in the Ministry of Education or the local authority.

The ISE is based on: nationwide deployment of hardware and communications. A computer head-quarter center, based in Jerusalem, holds a 3090 I.B.M. system, Unissis and several DEC computers. The country is divided into seven districts each having its own computer center (DEC computer). The centers and schools and other sites there are hundreds of PC's. All the computer systems (not including schools) are interconnected and accessible on line. The intention is to put all systems on a wide area network which will be an overall educational network including schools and local authorities.

The policy of the Ministry of Education tends to lead to decentralization in information systems with central command and control. In order to do that, the Ministry, established a logistical system for data collection as close as possible to the generation of data. The system should enable: inter system (horizontal and vertical) transfer of information, provision of relevant, accurate, complete and available information at all user levels, standardization of information - determination of data standards for interfaces and processes, extensive use of technological innovations in the areas of communications and computerization, appropriate tools for each unit (subsystem); end users in schools, pedagogic centers and other educational entities, establishing two-way communication between them and the central information systems (Ministry of Education, authorities, research institutions, etc.).

The objective of ISE in Israel is to supply and support all users with accessible, reliable and updated data, and improved service to end users: staff, students and teachers. System effectiveness should be increased (reduction of the administrative burden; allocation of inputs to educational tasks). The recognition of the importance of information as a crucial resource led the government to establish a senior unit for information systems.

The structure of the Information System in Education [4,5,6,7] rests on three main axes:

Teaching personel
Students
Institutional data and curricula

Data are stored at three information levels:

* **Head quarter level** - at which general data are stored pertaining to the entire population.

The more peripheral the user, the smaller the population covered and the greater the level of detail. At the same time, there are many areas in which the staff level - i.e., the Ministry - maintains individual data for the needs of special projects of national importance.

* **District level** - storing information pertaining to the district and more extensive information concerning the school such as requirment study hours, subjects, etc.

Areas handled at these levels include:

Student achievements (aggregate, not for individual students)
Student dropout rates
Accidents, violence, insurance
Allocation of resources (standard per student)
Handling different population groups (gifted, special education, immigrants)
Planning of teaching personnel training
Curricula
Construction planning, registration areas, transportation

* **School level** - detailed student data management, on the level of test and term mark; teacher data management, such as attendance and weekly lesson plans.

Systems operating within the school include:

SMIS (School Management Information System) - a tool for improving the effectiveness of the educational system in school; a standalone information system which enables data retrieval for decision making and management based on exceptional cases; a standardized tool enabling communication among all entities on a need-to-know basis. This latter tool allows internal control and supervision within the school through objective planning and performance control.

Self Evaluation - a tool for management of a pool of items and tests, test generation, and input of test results and data. This enables immediate assessment, from the teacher/coordinator/principal level (study of individual tests and student achievements) through the classroom level to the district and national level.

Telecommunications - for transfer of required report data to the various educational entities: Ministry of Education, owners of educational institutions, local authorities. It provides access to administrative databases (such as Director-General's circulars) and educational databases. It also has a capacity for technological communication among students and teachers, discussion groups, research projects, social education.

## CONCLUSION

Information systems in education are operated according to the policy of the educational system, which determines the information management policy. The objective is to obtain the following:

Effective management through data and information
Planning and supervision
Compatibility of standardization
Availability of tools utilizing innovative computerization technologies

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# 7

# Case study of the Information Systems Strategy (ISS) of the Hong Kong Education Department

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## Abstract

To improve the efficiency and effectiveness of Hong Kong education, the Education Department has embarked on an Information Systems Strategy (ISS). Under this five-year strategy, Information Technology will be employed to develop an integrated computer network linking the department and over 1,500 public sector primary and secondary schools. On implementation of this 70 million US dollars project, much of the manpower and resources currently engaged in information processing will be saved. Furthermore, the information infrastructure will provide the strategic information necessary for policy making, putting the department in a better position to meet the challenges of the 21st century.

Keyword Codes: H.4.0; H.2.8; H.5.3
Keywords: Information Systems, General; Database Applications; Information Interfaces

## 1. BACKGROUND

Education has been one of the top priorities of the Hong Kong Government. Given our lack of natural resources, maintaining a highly educated work force is the best investment to ensure that our economy would continue to thrive and remain vibrant to meet the challenges of the years ahead.

Against the backdrop of years of economic development and an increasingly open government, the last decade has seen rapid changes in our education system. As the education services become more sophisticated and the focus shifts towards the quality aspects in education, school administration and management have become more complex. Concern has been repeatedly voiced that, while coping with day to day administration, teachers are spending less time in teaching activities, pastoral care for individual students and their own professional development.

In tandem, the demand for information to support various management functions is ever rising. This trend coupled with the evolution of the society towards a more participative governance, has imposed a heavy demand on managers for information. Pressure is not only felt by the administrators who are accountable to the legislature for resources they control, teachers and school authorities have also been required to contribute data and information from their predominantly manual records for collation by traditional means.

To cope with such changes, Information Technology (IT) has been used in some schools and the Education Department (ED) to support their routine operational, administrative and management processes. However, the use of IT in such a piecemeal manner has serious limitations.

At the school end, we find pockets of computer expertise which drives an uneven pace of change. Some schools have had years of computerisation experience and developed sophisticated applications on very powerful platforms, while other less well endowed establishments still rely heavily on clerical procedures to carry out daily routines.

The same is true for the Education Department. Moreover, as much business is transacted among sections within ED, the fragmented approach has resulted in duplication and inconsistency of data. More unsatisfactory is the fact that almost all transactions between schools and ED have to be carried out through the use of paper documents, the source of which information could well be already resident in computers to some extent. This clearly represents an inefficient utilisation of the human resources.

## 2. CONSULTANCY STUDY

Concurrent with these developments, the Hong Kong Government has been actively pursuing reforms in its management procedures with the aim of improving efficiency and providing better service to the public with the resources available. Like all governments, the Hong Kong administration is constantly facing difficult choices in satisfying a myriad of wants spread over a wide range of social services. Following a high level review, the Hong Kong Government embarked on the Public Sector Reform in 1989. The salient principle of the reform is to establish a closer match between resource responsibilities and management responsibilities.

Taking the reform to the Schools Education Programme, ED introduced in March 1989 "The School Management Initiative - Setting the framework for quality in Hong Kong schools". This document set out plans and strategy for achievement of quality education through enhanced management procedures within all public sector schools. The intention of the policy was that management roles would be better defined, resource responsibilities and management responsibilities would be more aligned and schools would be enjoying a greater degree of autonomy in their own administration and resource control. In short, "more management and less administration" is the spirit of the initiative.

As the whole system becomes more decentralised, there is a dire need for improved information capabilities in order to support decisions at various levels. In recognition of this, a consultancy firm was engaged by the Hong Kong Government at the end of 1991 to conduct a study into the information needs of the school education programme. Based on the strategic direction and objectives of the school education programme and the current degree of computer use, the consultants gave their objective assessments on the information requirements of the school education programme, and some initial views about opportunities for using IT within it.

Referring to these recommendations, the consultants then engaged in a follow-up study to review and examine the strategic options available to meet the information needs of the school education programme. The options considered related to a portfolio of applications that Government should consider implementing over the next five years and the technical and organisational infrastructure that would be required to support them.

As a result, the consultants recommended the implementation of an Information Systems Strategy (ISS). Initially, they identified sixteen application portfolios, some targeting the improvement to operational efficiency while others involved the provision of an informed basis for planning or decision making. Obviously, the financial implications for developing such a whole-scale integrated system were expected to be enormous by any standards. Considering the level of resources required, the risk of failure, and the impact on the organisation, the consultants thus recommended a set of core applications that would ensure that ED can respond to policy imperatives, build a flexible infrastructure for the future and undertake a manageable project load.

The strategy, in brief, consists of applications built on a three-tier model using the client-server approach. They would link all schools to the district education offices which in turn are connected to the ED headquarters. The hardware to support the applications portfolio comprises a number of components such as a mainframe computer at the headquarters, a number of mid-range computers located at the district education offices, and a local area network at schools. The technical framework to support the application portfolio should be designed on the basis of key principles such as ease of use, effectiveness, efficiency, and flexibility.

The consultants envisaged that the most important benefit to the people of Hong Kong from Government investment in the ISS would be in the substantial amount of extra time that teaching staff would be able to devote to individual students both in learning tasks and with personal problems and issues. This would not only make a significant contribution to the prosperity and well-being of Hong Kong in the medium to long term by raising the skills, abilities and awareness of the population, but may immediately help avert some of the more drastic consequences of the currently intensely competitive nature of education. These substantial gains, achieved by relieving teaching staff of many of the routine administrative tasks that take up so much of their time, would be equivalent to an additional 1,400 man-years of additional teacher effort per year.

At the same time there would be significant improvements in the efficiency and effectiveness of administering the educational services, which, in turn, would free resources and give taxpayers more value for money. Additionally, facilities in these applications would be critical for the implementation of a series of new policy initiatives, which require considerable information support.

In April 1993, the Government accepted the recommendations. Then in September 1993, the ISS was given the green light to proceed at an estimated cost of 70 million US dollars over a period of five years.

## 3. SCOPE OF THE INFORMATION SYSTEMS STRATEGY

The ISS is basically a large scale computerisation project consisting of the following nine major components and two supporting projects:-

> *School Administration and Management System* - a computerised information system for schools to support management, planning and administration;
>
> *Integrated Student and School Applications* - a set of core databases of students and schools, and a revamped computer system to support allocation of school places at key levels;
>
> *Teacher Information Management System* - a core database of teachers, to support various kinds of processing such as teacher registration;
>
> *Office Systems* - computing facilities for data transfer and internal communication;

*Financial Management and Budgeting* - functions to support financial management of resources;

*Forecasting, Planning and Statistical Tools* - provision of software tools for planning and analysis purposes;

*Management Information System* - provision of software tools to support decision making by senior management;

*Initial Curriculum Resource Enquiry* - a database accessible to teachers containing basic index and synopsis of curriculum resources as an initial measure to facilitate efficient use of curriculum material;

*Pilot Geographical Information Management* - a pilot to evaluate the use of digital storage of graphical data such as school building plans;

*Data Standardisation and Administration* - identification of corporate data model and standardisation of data items; and

*Technical Infrastructure* - project to handle the technical aspects of the other component projects in the ISS.

## 4. IMPLICATIONS

The integrated approach to computerisation in our school education programme will result in a variety of benefits, some of which are described below.

Teachers will be relieved of many of the routine administrative tasks. The effort thus saved will enable teachers to devote more of their time to individual students both in learning tasks and in dealing with personal problems and issues. With better access to audio-visual and curriculum resource material, the quality of classroom teaching will also improve.

By extension, students will receive more attention from teachers. Timely assistance and guidance can be provided to those students in need. With the help of the computer, parents will find it easier to locate a suitable school place for their child. Members of the public will also enjoy a better enquiry service because, with the provision of on-line access to territory-wide information kept in the central databases, a "one-stop" service to clients can be provided.

The management information system will save a substantial amount of clerical effort on routine administration work. With better information support, schools will become more efficient in planning and managing their human and financial resources. The markedly improved communications with ED and the storage of key data in core databases will greatly facilitate enquiries related to teacher appointment, application procedures and education regulations.

In implementing the ISS, substantial improvement in the education services can be expected. The existing ageing operational systems will be replaced or re-engineered to converge with the information processing backbone. The new systems will be easier to use, less expensive to maintain, but more powerful in application. Transactions between schools and ED will be more direct and efficient, while paper flows will be significantly reduced, thus alleviating the manual collation and checking of necessary data and minimising the huge duplication of data on schools, teachers and students.

The ISS will also equip ED with a corporate database which will hold comprehensive, consistent and readily accessible information on schools, teachers and students. This, together with much greater computing power, will largely enhance strategic planning and effective deployment of resources.

The activities in the development cycle will also help all officers to focus on the informational aspects in operation, preparing them for the information explosion ushered in by the revolution in telecommunication. At the corporate level, the exercise will help to build up an organisation structure that can perpetuate the review orientation without which no organisation can hope to survive in this fast evolving world.

## 5. MAJOR ISSUES

While the above vision is highly optimistic, we have no illusion that the passage will be plain sailing. The following analysis will reveal some of our concerns.

The Hong Kong education system has evolved over a long period of time, drawing its traditions from both the East and the West. Thus there is extremely considerable diversity in schools and the whole system has become extremely complex. To take a few examples, we see vastly different types of curriculum being offered, many different modes of funding arrangements, and markedly different timetable structures. Whereas diversity and choice may be advantageous under open market conditions, this situation presents difficulties when data items need to be standardised at a corporate level. The system is further complicated by the fact that we have two official languages, English and Chinese, which are used in all formal correspondence and information exchanges. While computer processing in English is commonplace, the processing of information in Chinese has yet to be standardised.

The information system aims at providing an electronic linkage for no less than 1,500 schools. Its sheer size is a pioneering effort for Hong Kong. Unfortunately, we do not have the benefit of drawing from experience overseas. The tasks ahead will be particularly difficult once the system is fully integrated and requires the use of state-of-the-art approaches in some areas.

The implementation of ISS requires, in many instances, the redefining of roles and responsibilities for various users within the education system. Old procedures would have to be re-engineered and new ones set up to dovetail with the computer system operation. This would inevitably lead to pervasive changes in the practices and structure of both schools and ED. Understandably, there will be those who find the changes threatening and this could be the cause for some degree of resistance.

On the technical front, the scale of ISS has introduced issues for which difficult decisions will have to be made. A typical example is whether to centralise hardware and operators, distribute operators, or distribute both. The choice of technical options is further complicated by the number of small, remote schools, scattered all over the territory, where electronic linkage is limited and computer expertise may be non-existent.

## 6. MEASURES TO ENSURE SUCCESS

To address some of the above problems and to meet the challenges of the undertaking, a phased approach to implementation has been adopted whereby the system will be rolled out in batches to the smaller groups of users. This will hopefully achieve a smooth transition and help to contain teething problems.

To guarantee that the future system meet the needs of users at the school level, a "partnership" approach has been adopted where practising teachers and serving principals are actively involved during implementation. In pursuit of this objective, a number of briefings, seminars, interactive workshops and user brainstorming discussions have been held. Moreover, serving teachers and principals have been seconded to work closely with system engineers in the actual design work.

To improve user acceptance, the system will be designed with particular attention to user-interface techniques and the choice of software tools. Hopefully, the system will be user-friendly, even to novice users of IT.

Furthermore, pilots are being conducted in schools where prototypes are tested in an operational environment and the evaluation findings will serve as the basis of improvement. In the same vein, advanced technology will be piloted, until technology has proven records of success, before wider application at the school level.

Training is another pivotal point in development. A variety of programmes bundled in flexible and easy-to-use packages are being developed, which cater for the wide spectrum of trainees.

## 7. CONCLUSION

The above paragraphs have described the anticipated development of the ISS project in the next five years. We strongly believe that the informational infrastructure, harnessing IT for educational use, will become a vital part of our education system that could help teaching professional to keep up with the times.

During the gestation stage of ISS, we have sent officers overseas to look at similar integrated systems. Constrained by resources, these visits were necessarily limited. Thus we are setting our sight on further fact-finding visits in the near future.

The ITEM conference offers a welcome opportunity for contact with IT experts in the field of education. Hopefully, we shall be able to build the bridges to allow a free flow of ideas to help us meet the challenges as we move towards the 21st century.

# 8

# Computer-aided school management in North-Rhine Westphalia: The Kaufmaennische Schulen (College of Commerce) in Ahaus

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## Abstract

In the Federal Republic of Germany there is no uniform concept for computer-aided school administration. The authorities involved in administering schools as well as the schools themselves employ programs specially suited to their various demands. These programs employed in the schools must allow decentralized gathering of data. In order to minimize effort involved in changing the programs, the important conditions for writing reports are to be formalized in decision tables which can be evaluated by the program. In order to enable data communication between the parties involved, new developments should only take place on the basis of SQL-database systems.

Keyword Codes: B.4.m, K.3.0
Keywords: Input/Output and Data communications, Miscellaneous; Computing Milieux, Computers and Education, General

## 1. FRAMEWORK FOR SCHOOL MANAGEMENT: THE GERMAN SCHOOL SYSTEM

A systematic concept for computer-aided school management is not to be found in Germany. This is quite surprising, considering that the state of North-Rhine Westphalia alone employs 163,000 teachers in over 10,000 schools. About 22 % of the population of Germany lives in this state. School expenses play an important role in the budget of the 16 federal states.

The reason for the small degree of integration of computer systems in school administration lies in the structure of the German school system. There exists in the Federal Republic of Germany a separative school system, as can be seen in figure 1.

The school system in Germany is not centrally controlled. Each state has its own educational laws. The federal Ministers of Education jointly agree on their educational policies. They fix a framework for the curriculum for the individual subjects in the various school levels. Representatives from industry and the trade unions are also involved in the development of the curriculum of vocational schools. Within this national framework each state develops its own refined curricula. And in the schools themselves an internal curriculum is put into practice on the basis of the respective state's curriculum.

```
            Employment                        Higher education
                                               in specialised
=======================================        college/manage-
5          University                  |       ment school
4          Polytechnics                |
3  Colleges of Commerce + Technology   |  Employment
=====================================  |  =====================
13 Sekundar-       Gymnasium           |  Parallel dual training
12 stufe II        Fachoberschule      |  day release system
11 (Sixth Form     Berufsfachschule    |
   Colleges)       (Specialised        |
                     high school)      |
   ------------------------------------------------------------
10
09  Sekundar-      Gesamtschule       (Comprehension school)
08  stufe I        or Realschule      (Technical high school)
07  (Secondary     or Hauptschule     (Secondary modern school)
06   schools)      or Gymnasium       (Grammar school)
05
   ------------------------------------------------------------
04
03  Primarstufe   Grundschule
02  (Primary      (Junior school)
01   school)
   ------------------------------------------------------------
00 Kindergarten    (up to 5 years of age)
```

Figure 1. The German school system

Each state employs teachers corresponding to the estimated requirements. With very few exceptions all teachers must have completed a degree course at the university (M.A. or M.Sc.). The length of study varies: A student aiming for a position as a teacher at a primary school can complete his course of studies in about three years. Qualification of a teacher at a grammar school or college of higher education usually takes more than four years. The state is responsible for the practical training in the schools. This practical training lasts two years and is completed by a state exam. Teacher training is based on the relevant school subjects, and also includes pedagogy, philosophy, sociology and psychology. There is no systematic training in problems of school management at any phase of teacher training.

Exactly what kinds of schools are available in any region or city is a matter for the local authorities. In agreement with the Minister of Education or the subordinate authorities they must ensure that the basic educational requirements are met in all cases. As local level education is a very important political matter, politicians ensure that the young citizens are offered a wide choice of schools.

On the basis of these facts one can see that the German educational landscape is very varied. This impression is reinforced in the individual schools. The degree of variation within the schools is best seen in the example of colleges of higher education. It is hard to find even two that are structured in the same way.

## 2. BASIC FRAMEWORK FOR THE INTERNAL ORGANIZATION OF A SCHOOL

The head of the school, who is always a teacher, is the legal representative of the school and responsible for the organizational and pedagogical running of the school. He is supported by a deputy head. In the case of colleges of higher education, which are mostly divided into departments, the departmental heads take over some of the administrative tasks.

This committee determines in agreement with the local authorities (LEA) exactly how the internal administration is organized. Local authorities are responsible for fitting out the schools (buildings, rooms, computers, office personnel). As these authorities employ as little administrative personnel as possible for economical reasons, many of the administrative tasks must be executed by the teachers themselves. Computers are well suited for carrying out such work. Many local authorities are, however, not really interested in minimizing the teacher's administrative burden. On the one hand, buying computers and the required programs puts a strain on their budget, and on the other, the teacher's working time is a state matter. And the state for its part sees no reason to get involved in the administrative affairs of the local authorities.

The state of North-Rhine Westphalia is interested in equipping school administration with computers. Because it cannot force the local authorities to do this, it now plans to equip each school with a PC in the next few months. They are however not doing this with the aim of reducing the teacher's workload. The ministry's motive is that it would like to acquire up-to-date personnel planning data by means of a data communication system. In order to achieve this the schools have to supply data regarding numbers of pupils and employment of teachers four times a year. In order to motivate schools to undertake this statistical work, the Minister of Education supplies all interested schools with a time table production program as well as a student data administration program which run under the operating system MS-WINDOWS 3.1 in the single mode.

## 3. SCHEMES REALIZED FOR COMPUTER-AIDED SCHOOL MANAGEMENT

A large part of the administrative programs applied in colleges of higher education are the teacher's own initiative. The achievement spectrum ranges from monofunctional programs in DBASE to integrated program systems on UNIX-systems. The integrated program systems normally include the following functions:

- administration of student data
- writing of reports
- time-table production program
- production of the substitution plans
- lending of school books
- inventory administration
- statistics

### 3.1 Organizational requirements of a school administration application

The organizational requirements that must be met by school administration software can be illustrated by the following two aspects.

**Fluctuating workload**

In school administration the tasks occurring are not spread uniformly over the course of a school year. As can be seen in the figure 2 there are several peak work periods within the year.

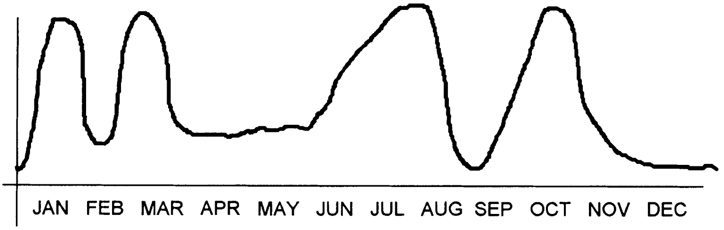

Figure 2. Peak work periods within the German school year

This work, e.g. writing reports, statistics, time-table production, students' matriculations and letters of acceptance normally has to be executed at very short notice. That is why teachers have to help the employees in the office.

**Student oriented form data**

A college of higher education normally includes several school types, each with its own curricula. For example, the Kaufmännische Schulen in Ahaus offer the following types of school:

1. Basic vocational school (commercial college)
2. Advanced vocational school (advanced commercial college)
3. Advanced vocational school with A-level qualification
4. Specialised high school (full time and part time)
5. Specialised school of economy , economy informatics
6. Vocational schools with classes for 10 different vocations.

Each type of school has its own report regulations. These must be closely adhered to because the school reports give the students particular qualifications. Just what qualifications they receive depends on their previous education as well as the average mark which they have achieved in their course of training. Due to the student oriented form data more than 140 form regulations must be obeyed at the Kaufmaennische Schulen Ahaus.

### 3.2 Consequences for hardware and software

**Decentralization**

The unstructured workload which has to be carried out in a few days makes a multi user system necessary. In the Kaufmaennische Schulen Ahaus we employ a UNIX-system to which 9 terminals, 3 printers and a card-reader for the marking cards are connected.

In order to enable decentralized input of data, the software has been designed so that depending on the application only reading, or writing and reading access to data is permissible. Furthermore safety measures had to be taken to ensure that access is only allowed to those users who are entitled to it. School office personnel has, for example, no access to school report data. On the other hand, the teachers responsible for writing reports have no writing access to time-table data.

The problem of having a large data input to be covered in a very short period, while minimizing individual effort is most clearly apparent in report writing. School reports are normally issued at the end of January as well as at the end of the school year in July. At the Kaufmaennische Schulen the marks of 2,000 students in an average of 12 subjects have to be gathered by about 70 teachers within three or four days. The input of marks into the mark files occurs at a time when the teachers already face an increased workload caused by their involvement in final examinations. That is why we had to develop a system for collecting marks that minimizes the workload. The solution is that the teachers mark the specially prepared computer-cards. The cards, which are issued at certain intervals, are fed into the computer in the morning breaks. The teachers all receive their own check-lists. If there are any errors, the teacher marks his correction on the list and gives them to the work-team responsible for report writing. One member of this team corrects the report file. This procedure has a number of decisive advantages over the collection of marks at a terminal:

- the teacher can collect his marks at a convenient time.
- the responsibility for collecting marks lies with the individual teacher.
- collecting marks is fully decentralized; in this way the time required for each individual is minimized.
- instruction in the marking procedure is clearly simpler than instruction of the teacher into operating the mark collecting program.
- the necessity of having to install rights of access to over 70 teachers with corresponding entitlements no longer exists for the system administrator (normally a teacher of informatics).

**Control of form organization**

The difficulty of ensuring that each student receives the correct form corresponding to his own type of schooling is also illustrated in the example of report writing. Reports not only include marks, but also additional remarks consisting of particular qualifications. That is why each report must be exactly matched to the type of schooling of the individual student.

The days on which the reports are issued are already filled with examinations and conferences. In the generally hectic atmosphere at the end of the school year many teachers lack the concentration to be able to issue the correct reports. A wrongly issued report have far-reaching consequences. Indeed, one school was taken to court and sued for compensation because a teacher had inadvertently employed incorrect report forms. Unfortunately this can easily happen because the Minister of Education frequently alters the legal regulations which can also lead to slight yet decisive changes in the texts of the reports. For this reason a school administration program must be designed in such a way that the teacher is only responsible for supplying the marks. All other data relevant to the writing of reports must be supplied in files or tables.

The school administration software must enable the report program to make alterations with minimal effort. This is because schools have no money for regular program updates. The program system must be structured in such a way that instructed teachers can carry out the necessary alterations without any great difficulty. This is best achieved by saving the data necessary for controlling forms in special parameters and decision tables. This presupposes that the conditions are described in a formalized manner or, alternatively, are converted into reference numbers. Thus the type of schooling of each student is clearly marked by a schooling type number in the students data record. Each type of schooling has its own table of subjects. It is also clearly indicated whether the mark for each subject is relevant to the calculation of the student's average mark.

| School type number | 32301 | 32301 | 32301 | 32301 | 32301 |
|---|---|---|---|---|---|
| type of report | leaving certificate | final report | final report | final report | intermediate report |
| previous education | -- | D | E | F | -- |
| average mark | -- | < 2.5 | < 2.5 | < 2.5 | -- |
| form number | 32301.1 | 32301.2 | 32301.3 | 32301.4 | 32301.0 |

Figure 3. Structure of the decision table for writing reports

Parameters as well as the conditions which are important for writing reports are collected in decision tables as can be seen in figure 3 and are evaluated by the report program. The system administrator keeps the decision tables and produces the necessary form files. By this method of creating parameters one can ensure that the teachers are only involved in supplying marks on the computer cards.

## 4. DIFFICULTIES OF IMPLEMENTING THE INTEGRATED DATA PROCESSING CONCEPT

An integrated school administration application can only be successfully employed when it is matched by the internal organization of the school. Therefore a team of teachers must be formed that takes over the tasks of system administration. In compensation they receive a reduction in their weekly teaching load. If, however, other teachers cannot take on the extra lessons thus incurred, an integrated concept should be avoided..

The school administration applications which were developed predominantly according to the motto “teachers help teachers“, 10 to 15 years ago, require updating. Further development in BASIC no longer seems to be a suitable solution. The new concept must be based on a database system which can be administered by SQL. The necessary procedural components are to be written in COBOL or C++. It is of the greatest importance that the school administration application runs under the following operating systems: UNIX, NOVELL and WINDOWS. Only this can guarantee that the individual features of the schools are taken into consideration.

When developing new software, the ministry will only develop the software it needs for its own purposes because of the law concerning its budget. The local authorities will also only be interested in the software relevant to themselves. The schools for their part will write the programs they need themselves. However, if all three parties in the field of school administration agree on one data framework and one filing system, there is indeed a chance that the separate developments will lead to an all-embracing program system.

# 9

# The Development of Computer Assisted School Administration in New Zealand: A Case Study

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## Abstract

This paper reports the development of computer assisted school administration (CASA) in New Zealand as a case study based on the Massey University School Administration by Computer Project, commonly known as MUSAC. Over five years, MUSAC software has been acquired by 67% of all New Zealand schools either using, or likely to use, computers for administrative purposes. The Study is in four sections which: outline the grass roots form that CASA development in general has taken; describe the New Zealand school system in terms of its role as a market; tell the story of MUSAC in terms of its origins, development strategies and attributes of the software; analyse and interpret the MUSAC software acquisition and use patterns of schools using educational management and administration (EMA) concepts; and conclude with a summary of the findings and discussion of implications for ongoing research and development.

Keyword Codes: H.4.1; K.3.1
Keywords: School Administration; Educational Management; Computers; Information Technology.

## 1. INTRODUCTION

New Zealand school administration software appears similar in both structure and content to that found in other school systems e.g. OASIS software used by NSW Schools in Australia [1]. The New Zealand approach to software development and to its adoption and use by schools seems, however, to be markedly different for two reasons. Firstly, the New Zealand Government has, from the early 1980s, maintained a policy of non- involvement. It does not play a role in the development of software and it does not fund schools to purchase hardware and software for administrative purposes. Secondly, and partly in response to the Government policy of non-involvement, grassroots initiatives in New Zealand have independently provided schools with the administrative software solutions and strategies they require.

One particular initiative, The Massey University School Administration by Computer project (known throughout New Zealand schools as MUSAC) epitomises this grassroots development. Since establishment in 1989, MUSAC software has been acquired by 67%[1] of all New Zealand schools either using computers, or likely to use them, in support of school management and administration. Moreover, at a point when nationwide research (e.g. surveys of software acquisition and use patterns) has not yet been carried out, MUSAC records contain the only systematically collected data on this topic. Arguably, the records provide the best available data required to gauge the extent of computer assisted school administration for the country as a whole.

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[1] Since data analysis in March 1994, the number of MUSAC using schools has increased to over 70%.

### 1.1 Purpose

Accordingly, this Paper reports the development of computer assisted school administration (CASA) in New Zealand as a case study based on MUSAC. The Study is in sections covering: the general grass roots form that CASA development has taken; the New Zealand school system in terms of its role as a market; the story of MUSAC in terms of its origins, development strategies and attributes of the software; analysis and interpretation of MUSAC software acquisition and use patterns of schools, using educational management and administration (EMA) concepts; and conclusions which summarise the findings and examine implications for ongoing research and development of CASA.

### 1.2 Position

The position taken is that research is a key step necessary in helping schools to: (i) better understand ways that computer technology might be used to enhance school management and administration; and (ii) fully exploit the capability of information technology as an educational management and administration resource. Contemporary experience [4] generally, and the experience of MUSAC in particular, shows that success in this enterprise depends on end users, developers and researchers working collaboratively. The "grassroots" development of this relationship is the underlying theme of the Paper.

## 2. THE DEVELOPMENT OF CASA IN NEW ZEALAND

As in other countries [6], teacher enthusiasts, with computer programming skills, pioneered the development of CASA in New Zealand during the late 1970s. Generally, they defined their mission as developing programs to help school administrators economise on the use of their time, i.e. be more efficient. Thus, programs were developed to deal with such recurring, but key, administrative tasks as scheduling, pupil registration, school accounting and marks analysis. In some instances, the developers formed school-based businesses and generated revenue for their schools. For example, MUSAC software was initially developed in this way. Others left teaching and formed small school software businesses and marketed their products to schools in the local region.

CASA development, thus initiated [5], was largely uncoordinated and ad hoc in character, resulting in a diversity of functional, integrated and single purpose software solutions and strategies. Designed by teachers and school administrators who understood schools and how they worked, the solutions tended to be well received because they met administrative and management needs as defined by the schools themselves. As the principal developer of MUSAC once commented: "Our first priority was to develop computerised methods and procedures that would help schools become masters of their own destinies and managers of their own affairs".

From around the mid-1980s, commercial organisations such as banks, accountancy firms and business software houses entered the field. Not infrequently, they sold business software to schools straight off the shelf. Government restructuring of the education system and the mandating of individual schools to manage themselves in the late 1980s quickened schools' interest in the use of computers. More often than not, this was because they saw computers as a means of rendering school administration more efficient and effective at a time when the work loads of administrators and teachers alike seemed to be increasing dramatically.

In Visscher's [5] terms, this was a time of transition from the stage of initiation to a stage of expansion as both the business community and the schools themselves began to recognise more clearly, though from somewhat different perspectives, the potential of computers to support school administration. On the whole, the school software businesses seem to have been more successful than the commercial organisations for two reasons: (i) they understood better than the commercial organisations the distinctive data and information processing requirements of schools; and (ii) they designed special purpose applications capable of doing what the schools wanted. The more advanced packages incorporated an integration feature with the capability to transport data between applications.

During the expansion stage, probably still in progress for a significant minority of schools, individual schools grappled with the different but related challenges of: (i) managing the computer environment in a technical sense; and (ii) understanding how the much vaunted benefits for school administration might be realised.

The accelerated rate at which schools have acquired administrative hardware and software during the late 1980s and early 1990s (e.g. 100 MUSAC-using schools in January 1989 to approximately 1300 in May 1994) would seem to indicate, in terms of the system as whole, that New Zealand schools have now effectively integrated computer technology into their day to day management and administrative practice. Judging by the MUSAC software acquisition patterns analysed later in the Paper, a great many schools from across the full spectrum of school types have, moreover, achieved a state of consolidation. That is to say, they have, in Visscher's [5] terms: (i) achieved the automation of activities goal (viz. the improvement of the efficiency of clerical activities) characteristic of initiation and expansion; and (ii) shifted attention from the management of computerisation to the management of information. As the MUSAC data also show, however, the way schools actually manage information (i.e. their use patterns) may vary across types of schools, though not across school sectors.

## 2.1. The New Zealand School System

The information in Table 1 on the school sectors and types[2] of school in New Zealand, along with percentages of schools which use MUSAC software, sets the scene for the Case Study.

MUSAC-using schools (1253) taken as a fraction of all schools in New Zealand (2795), represent only 46% of the total. It is important to note, however, that few, if any, schools with five or less teachers (938 out of 2221, i.e. 42% of all primary schools) either use computer technology for administration or can be expected to do so in the foreseeable future. In terms of their small size and limited financial resources, expenditure on in-school administrative computing is perceived as not being justified. Accordingly, schools with five or less teachers are excluded from the estimated size of the school market used in the analyses of this Paper. All schools in each of the remaining three school types (intermediate, secondary and area) are either using computers for administration or have the potential to do so. In light of these considerations, the size of the school market for computer administration software is shown in the Table as 1857 schools and MUSAC's share of this market (1253/1857) as 67%.

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[2] **School types in New Zealand:** Primary schools consist of contributing (925) and full (1251) primaries which cater respectively for 5 to 10 year olds (K to 5) and 5 to 12 year olds (K to 7), ranging from single teacher schools in geographically remote areas to large urban schools with 20 or more teachers. Intermediate schools (a form of two year middle school common in the USA) cater for the education of 11 to 12 year olds in Grades 6 and 7 with students fed into them from surrounding contributing primary schools. Secondary schools may include 11 to 17 year olds (Grades 6 to 12), though typically they encompass the lesser age range from 13 to 17 (Grades 8 to 12). Area schools, typically in remote areas where only one school is justified to serve a community, encompass the full age and grade range from 5 to 17 years (K to 12).

**Table 1**
**Schools in New Zealand by Type, Sector, MUSAC Users**

| Sectors / Types | State | Integrated | Private | Total | MUSAC Users | |
|---|---|---|---|---|---|---|
| Primary | 1939<br>(1149)* | 212<br>(104) | 70<br>(30) | 2221<br>(1283) | N<br>881 | %<br>69 |
| Intermediate | 147 | 0 | 2 | 149 | 103 | 69 |
| Secondary | 257 | 62 | 19 | 338 | 253 | 75 |
| Area | 37 | 6 | 44 | 87 | 16 | 18 |
| Total | 2380<br>(1590) | 280<br>(172) | 135<br>(95) | 2795<br>(1857) | 1253 | 67 |

* ( ) = adjusted totals after removal of primary schools with 5 or less teachers.

The market extends across all three school sectors. Thus, the MUSAC data base of user records makes no distinction between schools on the basis of sector identity. School type appears, however, to consist of sub-markets within the overall school market. As the analyses and interpretations which follow later in the case study show, school type is a variable which influences both the acquisition of administrative software, and, its pattern of use.

## 3. THE MUSAC CASE STUDY

The MUSAC Project was established in 1989 as a university-based, as distinct from a Government or private sector-based, initiative. Located within the Educational Research and Development Centre of Massey University, its mission is to:

> create, and market to New Zealand schools, a comprehensive computerised school administration system that will enable school administrators and teachers to meet the challenge, set for them by Government, to govern themselves, direct their own development, rather than be directed from without as in the past, and become wholly responsible for making their own decisions and managing their own affairs.

Given the limited budgets within which most New Zealand schools operate and the relative paucity of their computer knowledge, three further requirements were built into the MUSAC development brief. The software must also be affordable, user friendly and robust.

### 3.1 Origins

Prior to the establishment of MUSAC, various other school administration software developed overseas (e.g. the OASIS package (1) from NSW, Australia) were considered by the University for adoption in New Zealand. The final decision to "go with a home grown solution" was taken for a number of reasons: (i) such a solution already existed; (ii) it had built into its design most, if not all, the functionality already observed in overseas systems; (iii) schools already using it reported that it worked well and they were confident that it would appeal to others; and (iv) the software design philosophy, involving such attributes as responsiveness, flexibility and inventiveness, fitted with the values of Massey University faculty who saw CASA as a means of facilitating administrative practices shown to be effective by contemporary experience and research [3,4], e.g. collaborative decision making and participatory management.

The precursor to MUSAC, called the Waiopehu Package, was developed by its teacher-inventor, part-time over about five years, as an extra curricula interest, to assist one secondary school, Waiopehu College. Beginning in 1985, he adopted a developmental approach in the sense of creating two generic programs to address two general tasks commonly perceived by school administrators as central to the operation of schools as educational organisations: Pupil Files to deal with a range of data and information integral to the management of pupils; and, Accounts to deal with the financial accounting aspects of school management and administration. An integration capability was built in from the outset thus permitting the transfer of data and information between the two core programs and others that would be developed later.

Between 1985 and 1987, five new packages were added. Four were designed to complement Pupil Files and extended the range of pupil management functions amenable to treatment via computer. They included Marks Analysis in 1986 and Electronic Markbook, Absences and Timetable in 1987. School Wages was added in 1987 to complement Accounts, further extending the computerisation of school financial management functions. Thus, by the time Massey University approached the developer in 1988 and invited him to form a University-based school administration software business (given the name MUSAC in early 1989), the Waiopehu Package was an integrated suite comprised of two general purpose and five special purpose administrative programs, designed so that exisitng programs could be continuously refined to meet existing needs better and others created to anticipate new needs.

### 3.2 Development plan

The MUSAC development plan, fomulated during establishment in 1989, was based on the assumption that success would depend on the schools themselves taking ownership of the enterprise. As with the Waiopehu Package, this would require school participation, i.e. "grassroots involvement" in all phases of software design from planning, through development testing to user evaluation. Consistent with the assumption, the Plan contained a strategy comprised of three elements: (i) the welcoming of flexibility and divergent approaches in the design of software which involves listening to, and valuing, the ideas of others in and outside of MUSAC, especially end-users; (ii) the adoption of a concept of "user friendliness" somewhat broader in scope than conventional definitions involving a user group, help desk and rewards to users for good ideas and error detection; and (iii) subscription by the software developers and customer support staff to a continuous problem-solving approach, with solutions provided by end-users being regularly incorporated into software updates.

All three of the above elements working together seem to have created an organisational culture which encourages MUSAC staff to be both responsive and anticipatory in their approach to software design. On the one hand, existing software is constantly being revised so as to better meet existing school needs, e.g. the release of Pupil Files Version 4 early in 1994. On the other hand, new software is constantly under development, anticipating changes and new developments, e.g. the introduction in 1994 of a National Qualifications Framework, whose implementation at the school level might be enhanced or, made more manageable, by the use of competent purpose designed software, e.g. a program for recording and analysing student achievement. To this end, MUSAC staff constantly update their knowledge of both technical computer developments and educational developments affecting the schools. They do this by regular attendance at training workshops and computer conferences (e.g. COMDEX in the USA) and by constantly liaising with the schools themselves and with Ministry of Education officials.

On the face of it, features of the software attributable to the MUSAC culture and its strategy may appear unremarkable. The point is, of course, that a great deal of school administration software, by lacking one or more of the three elements mentioned above, commits schools to maintenance of the status quo rather than to the adoption of a reflective-developmental administrative philosophy and approach. Writers such as Naisbitt have shown that the latter is essential if schools are to function effectively in the rapidly changing society of today and tomorrow.

### 3.3. The MUSAC package

By 1994, the complete MUSAC package has been developed as a fully field tested, integrated suite of 15 school data and information processing Programs[3]. They are organised as modules covering four generic categories of educational management and administration (EMA) functions. It is noted here, in anticipation of the analyses to come, that the acronym **EMA,** standing for **Educational Management and Administration**, is used to name two constructs, **EMA Category** and **EMA Type**, which are the two main descriptive and analysis tools of the paper. It should also be noted that EMA Type, which refers to the way combinations of programs are used in schools, differs from **School Type** which refers to the four categories of school in New Zealand - primary, intermediate, secondary and area schools.

In Table 2 below, the programs of the MUSAC package are located on the vertical axis against the EMA category to which they belong. EMA category 1 is subdivided into three sub-categories to distinguish programs in three different, but related, aspects of the Pupil Management function, namely pupil organisation, performance and behaviour. EMA category 4 refers to User Group and Help Desk which are facilities rather than programs. It anticipates the instructional programs yet to be developed but acknowledges the role that User Group and Help Desk play in lieu of such programs. The remaining two categories, Learning Resource Management and Administration and Financial Management complete the set within which MUSAC sofware has been developed to date. Thus organised, Table 2 identifies the year in which each program was made available for school use and displays the pattern of MUSAC software acquisition across school types.

As with other school administration software, MUSAC software permits networking, thus enabling decentralised access and interaction through remote terminals. The inclusion of such a facility could be taken as a MUSAC commitment to the development of professional collegiality and collaboration. Experience and research (3,4) have demonstrated that such characteristics are commonly associated with effective school administration. Ease of information sharing, made possible through computer technology, facilitates this effectiveness.

## 4. ANALYSIS AND INTERPRETATION: ACQUISITION AND USE PATTERNS

### 4.1 Acquisition patterns

Examination of Table 2 reveals that three MUSAC programs predominate. The programs are: **Pupil Files** - primary (76%), intermediate (92%), secondary (87%), area (94%); **Accounts** - primary (66%), intermediate (71%), secondary (65%), area (81%); and **Resource Manager** - primary (53%), intermediate (72%), secondary (60%), area (94%).

The pattern is partly explained in terms of the status of Pupil Files and Accounts as the core programs of the MUSAC suite. The prior installation of Pupil Files is necessary in order to run nine other programs, namely: Modules and Exam Entries (pupil organisation); Marks Analysis, Markbook, Progress Monitor and Reports (pupil performance); and Absences and Discipline (pupil behaviour). The specific programs used reflect schools' particular priorities for information processing in the general area of pupil management. The use of Accounts and Resource Manager is linked with financial accountability requirements. The requirements are pressing nowadays with New Zealand schools expected to operate as, in the words of one commentator, "viable business entities".

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[3] Two new programs, Achievement Record and Financial Management, will be released to schools in 1994.

The high membership of **User Group** (not less than 90% for any school type) signifies two concerns that schools frequently express: (i) that access to back-up and support is available when required; and (ii) that the User Group will provide school staff with a form of training (self instruction using manuals and contact with the Help Desk) but that other forms of training are also required. The latter is evident in the high demand for, and attendance at, regional training seminars conducted by MUSAC staff and the proliferation of on-site training provided by 12 independent MUSAC regional support agencies which have come into existence over the past five years.

**Table 2**
**Distribution of MUSAC Programs by EMA Category for All School Types, March 1994**

| **MUSAC Programs** | **Dates** | **Primary** | | **Intermediate** | | **Secondary** | | **Area** | | **Programs in Use** | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **EMA Category 1: Pupil Management** | | | | | | | | | | | |
| **Organisation:** | | N | % | N | % | N | % | N | % | N | % |
| Pupil Files | 1985 | 668 | 76 | 95 | 92 | 221 | 87 | 15 | 94 | 999 | 80 |
| Time Table | 1987 | 6 | <1 | 3 | 3 | 202 | 80 | 6 | 38 | 217 | 17 |
| Modules | 1992 | 0 | 0 | 0 | 0 | 25 | 10 | 0 | 4 | 25 | 2 |
| Examination Entries | 1992 | 3 | <1 | 0 | 0 | 137 | 54 | 1 | 6 | 141 | 11 |
| **Performance:** | | | | | | | | | | | |
| Marks Analysis | 1986 | 2 | <1 | 2 | 2 | 175 | 69 | 4 | 25 | 183 | 15 |
| Electronic Markbook | 1987 | 5 | <1 | 6 | 6 | 177 | 70 | 3 | 19 | 191 | 15 |
| Progress Monitor | 1993 | 166 | 19 | 37 | 36 | 46 | 18 | 0 | 0 | 249 | 20 |
| School Reports | 1992 | 3 | <1 | 6 | 6 | 50 | 20 | 0 | 0 | 59 | 1 |
| **Behaviour:** | | | | | | | | | | | |
| Discipline | 1993 | 8 | <1 | 6 | 6 | 17 | 7 | 2 | 13 | 33 | 1 |
| Absences | 1987 | 19 | 2 | 9 | 9 | 161 | 64 | 3 | 13 | 192 | 15 |
| **EMA Category 2: Learning Resource Management** | | | | | | | | | | | |
| MUSAC Library | 1991 | 212 | 24 | 42 | 41 | 83 | 33 | 6 | 38 | 343 | 27 |
| Bar Codes | 1992 | 17 | 2 | 4 | 4 | 10 | 4 | 0 | 0 | 31 | 2 |
| **EMA Category3: Administration and Financial Management** | | | | | | | | | | | |
| MUSAC Accounts | 1985 | 585 | 66 | 73 | 71 | 163 | 65 | 13 | 81 | 834 | 67 |
| Resource Manager | 1989 | 469 | 53 | 74 | 72 | 153 | 60 | 15 | 94 | 711 | 57 |
| MUSAC Payroll | 1987 | 37 | 4 | 9 | 8 | 61 | 24 | 3 | 19 | 110 | 9 |
| **EMA Category 4: Staff Training and Support** | | | | | | | | | | | |
| User Group | 1989 | 786 | 90 | 98 | 95 | 233 | 92 | 16 | 100 | 1133 | 90 |
| | **TOTAL** | **881** | **100** | **103** | **100** | **253** | **100** | **16** | **100** | **1253** | **100** |

The acquisition patterns for other programs reflects varying school needs for different kinds of processing capability. For instance, the relatively low acquisition rate of Library (not more than 41% of schools of any type) may be due to a number of factors: the fact that large libraries requiring search capabilities and automated borrowing methods are found mainly in secondary, area and intermediate schools and not the primaries, the classroom-based way that libraries are used in primary schools, or, simply, that the program has only been available for three years!

More specialised programs such as Timetable, Marks Analysis and Markbook, commonly found in secondary schools and to some extent in area schools, are not configured for use in primary and intermediate schools. The latter have simpler scheduling requirements (i.e. a one teacher per class pattern) and are less dependent on examinations as their main assessment procedure. The acquisition of Progress Monitor by a small but significant number of primary, intermediate and secondary schools (19%, 37% and 18% respectively) reflects the importance that these schools attach to teachers maintaining high quality, regularly updated, records of student progress but minimising the time required to do this task.

### 4.2 Use patterns

For the purposes of analysis, it is assumed that the greater the number of programs and the combinations of categories of programs acquired by any given school, then the greater the likelihood that the programs are actually being used. In days gone by, the fact that a school had acquired new technology was no guarantee that this was the case. For instance, teaching machines of the 1960s were typically put in a cupboard at the back of the classroom and left to gather dust [2].

Three sources of information, however, support the assumption: once schools have acquired a first MUSAC package, and presumably mastered it, they tend to acquire further packages; there is a steady increase in the rate of acquisition, approximately 20% per annum; and the continuing heavy membership of User Group and extensive use of the Help Desk indicates that the programs are being used and not just "left sitting on the shelf".

### 4.3 Method

Data contained in the MUSAC data base of user records is in the form of strings of letters standing for the MUSAC programs used by each school, e.g. a three item string, 'gpu' stands for Progress Monitor, Pupil Files and User Group. The greater the number of items in each string, the greater the number of program combinations likely to be found in a school. The following three step procedure, using the **EMA** concepts referred to earlier, was devised to convert the data strings into a form suitable for analysis.

**Step 1** - involved sorting the primary data (i.e. programs) from the MUSAC records into 1,253 coded strings of letters, one string for each school, with strings ranging from one to 15 items and each letter standing for a particular program e.g. 'a' = Accounts, 'p' = Pupil Files 'u' = User Group.

**Step 2** - involved recoding the strings according to the **EMA category** from Table 2 to which each program belongs (viz. **P**=Pupil Management; **L**=Learning Resource Management; **A**=Administration and Financial Management; and **T**=Staff Training and Support) to produce a shorter EMA category string. The three examples below illustrate this step:

(i) a single item string such as the program, 'g' (Progress Monitor) would be coded 'P' because it is in the Pupil Management category;

**Table 3**
**Percentage and Cumulative Percentage of MUSAC Programs for Each School Type**

| | | C | | C | | C | | C | | C | | C | | C | | C | | C | | C | | C | | C | | C | | C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| School Type | % | % | % | % | % | % | % | % | % | % | % | % | C | % | C | % | % | % | % | % | % | % | % | % | % | % | % | % |
| Primary | 8 | 100 | 23 | 92 | 24 | 69 | 24 | 45 | 15 | 21 | 5 | 6 | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Intermediate | 7 | 100 | 12 | 93 | 13 | 81 | 26 | 68 | 22 | 42 | 11 | 20 | 5 | 9 | 2 | 4 | 2 | 2 | - | - | - | - | - | - | - | - | - | - |
| Area | 9 | 100 | 14 | 91 | 18 | 77 | 9 | 59 | 18 | 50 | 14 | 32 | 5 | 18 | 9 | 13 | 4 | 4 | - | - | - | - | - | - | - | - | - | - |
| Secondary | 6 | 100 | 5 | 94 | 6 | 89 | 5 | 83 | 3 | 78 | 10 | 75 | 10 | 65 | 8 | 55 | 17 | 47 | 12 | 30 | 9 | 18 | 6 | 9 | 3 | 13 | <1 | <1 |
| Programs per school | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | | 8 | | 9 | | 10 | | 11 | | 12 | | 13 | | 14 | |

(ii) a three item string, 'gpu' (Progress Monitor, Pupil Files and User Group) would be coded 'PT', i.e. a Pupil Management and Staff Training category combination; and

(iii) a five item string, 'alpru' (Accounts, Library, Pupil Files, Resource Manager and User Group) would be coded 'PLAT' which covers all four EMA categories.

**Step 3** - involved entry of the recoded data from **Step 2** into Matrices, one matrix for each school type, with **EMA** Types located on the Y-axis and 'Number of programs per school' (1 to 15) located on the 'X-axis. An **EMA Type** refers to the ways in which the strings of programs actually used in schools fall into particular EMA category combinations.

Because there are only four EMA categories, there can be only four **EMA Types.** Each is operationally defined below in terms of its constituent EMA category combinations:

EMA Type 1 - P, L, A, or T for schools using MUSAC programs in one EMA category;

EMA Type 2 - PL, PA, PT, LT, LA or AT for schools schools using MUSAC programs in two EMA categories;

EMA Type 3 - PAL, PAT, PLT or ALT for schools using MUSAC programs in three EMA categories; and

EMA Type 4 - PLAT for schools using MUSAC programs in all four EMA categories.

Schools in EMA Type 1 may be using as little as one MUSAC program and as many as 10, e.g. all the programs which belong to P, the Pupil Management category. An EMA Type 4 school cannot use less than four programs, i.e. one from each category, but may use up to fifteen i.e. all the MUSAC programs. Thus, four programs per school is the threshold across which any given school must pass in order to support a full range of EMA functions by computer.

### 4.4 EMA Type analyses

Examination of the distribution of 'programs per school' sets the scene for the EMA Type analyses which follow. Table 3 presents the relevant data in rows for each school type and split columns containing: (i) the

number of schools which has acquired a given number of programs (1 to 15) expressed as a percentage (%); and (ii) the cumulative percentage of schools (C %) which has acquired **up to** a given number of programs, beginning with 100% in column 1 and decreasing to 0%, e.g. 92% of primary schools use up-to 2 programs but no primary school is using 8 or more programs.
From the cumulative percentages in Table 3, it can be seen that marked differences exist between school types at the threshold point (column 4: 45%, 68%, 59% and 83% respectively for primary, intermediate, area and secondary schools). By column 7, the differences are of almost geometric proportions at 1%, 9%, 18% and 65% respectively.

**Diagram 1: Cummulative % of Programs per School Across School Types**

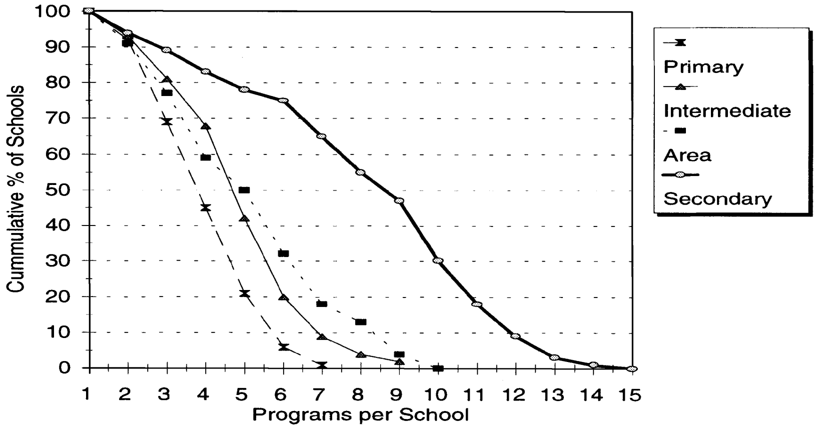
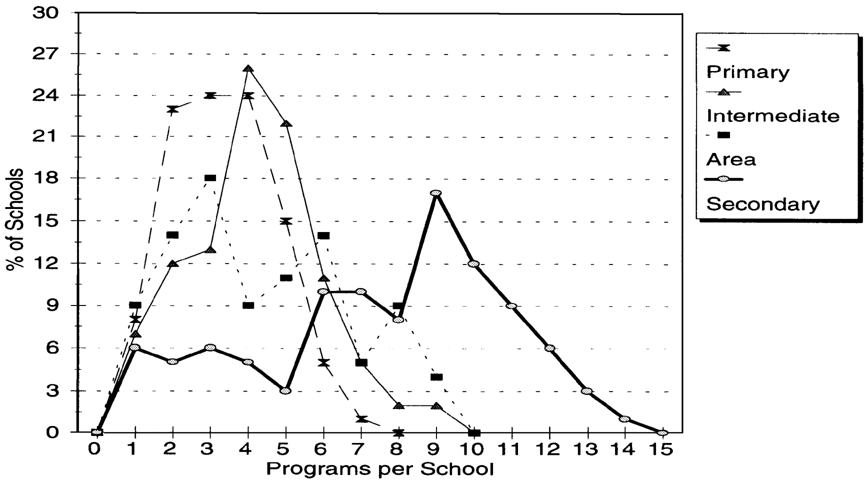


**Diagram 2: Distribution of Programs Per School for Each School Type**



Graphical representation of the cumulative data in Diagram 1 and graphs of the distribution of programs across school types in Diagram 2 further illustrates the differences. One interpretation is that secondary schools have achieved a much wider range of uses than the other three school types simply because they possess more programs.

The EMA Type analyses which follow next test this conclusion further by examining: (i) how **the contents** of the EMA Types are distributed across and within each school type; and (ii) how **the EMA Types themselves** are distributed across "programs per school" for each school type.

### 4.41 The contents of EMA Type across School Types

Pie diagrams displaying distribution data, presented together in Diagram 3, permit comparative contents analysis across school types for each EMA type. While the EMA categories P and A predominate across all four school types for EMA Type 1, there are variations in the percentage distributions which require comment.

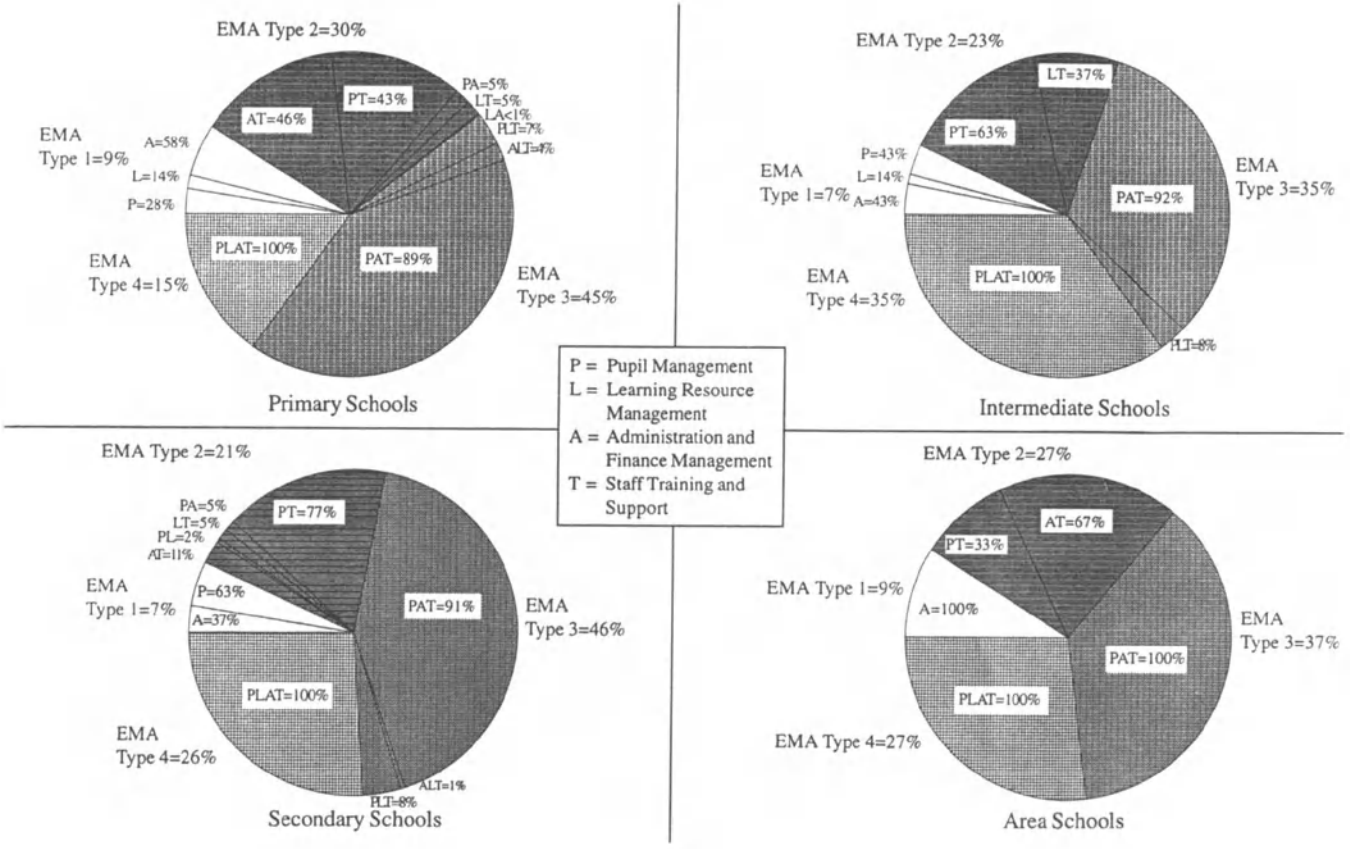
Primary schools have probably acquired financial management software (A = 58%) as their first priority for two reasons: they are learning how to function as an "educational business" and see such software as a good way to achieve this end; or use of the software enables them to manage their financial affairs more cheaply than hiring an agency to do the job, thus freeing up money for other resources. For secondary schools, more accustomed to managing themselves financially than primary schools, it is likely that Pupil Management takes priority (thus P = 63%). With intermediate schools, which fall between primary and secondary in the sense of combining attributes from both, it seems not too surprising that programs belonging to P and A have been acquired in equal numbers, viz. 43%. Area schools tend to have a small secondary department with the bulk of pupils at the primary level, perhaps accounting for the preponderance of category 'A' (100%) in EMA Type 1. With regard to the total absence of EMA category T and the relative absence of L, it may seem like stating the obvious but none the less it is worth noting that schools of any type are highly unlikely to: (i) seek training before they have acquired a program; and (ii) acquire a Learning Resource Management program in preference to say a Pupil or Financial Management program, when they are contemplating "getting into CASA". Two exceptions have been noted: some schools have acquired Library software (EMA category L) while using another software package for pupil management and/or administration and financial management; and some schools use an external agency to assist with the management of school finances.

Of the six EMA category combinations of EMA Type 2, the predominance of 'PT' and 'AT' is evident across all but one school type: primary - AT = 46% and PT = 43%; secondary - AT = 11% and PT = 77%; and area - AT = 67% and PT = 33%.; with intermediates the exception - PT = 63% and LT = 37%. An explanation is that schools in EMA Type 2 have embarked on CASA by electing to acquire and use one program upon commencement, supported by User Group membership and staff training. One measure of the success of their endeavours might be the future acquisition of additional programs in a different EMA category!

Of the four possible category combinations of EMA Type 3, the 'PAT' combination dominates: primary - 89%; intermediate - 92%; secondary - 91%; and area - 100%. This pattern seems to represent a kind of convergent evolution at the EMA Type 3 level. In Visscher's (5) terms, it might be interpreted as a form of consolidation forming the basis for ongoing CASA development at the EMA Type 4 level.

With 'PLAT' being the only combination in EMA Type 4, the percentage of schools operating in this Type indicates the extent to which the use threshold referred to earlier has been passed: Primary = 15%; Intermediate = 35%; Secondary = 27%; and Area = 26%. The pattern seems

**Diagram 3: Distribution of the Contents of EMA Types within each School Type**



paradoxical in that the secondary school type, with by far the greatest spread of programs, has fewer schools than might have been expected in EMA Type 4 while intermediates have more than expected. An attempt at explanation is made shortly when examining the distribution of EMA Types by 'programs per school'.

For the moment, the distribution patterns in the pie diagrams indicate the importance that schools of all types attach to the acquisition, and use, of combinations of P, A and T category programs. Indeed, it seems that the dominant progression is:

(i) acquisition, mastery and use of programs in EMA categories 'A' and 'P' first;

(ii) add Staff Training, category 'T' to ensure that mastery is achieved, which means that EMA Type 2 combinations 'PT' and 'AT' predominate (either initially or as the second step in program acquisition and use); and

(iii) precede to EMA Types 3 and 4, but with the EMA Type 3, 'PAT' combination of categories dominant as the basis for expanding the scope of CASA development.

### 4.22 Distribution of EMA Types across "programs per school"

The area charts, presented together in Diagram 4, enable comparisons of the way EMA Types are distributed across programs per school.

Although any given school in an EMA Type 1 could be using up to 10 programs, most schools in this EMA type use only one program, even the secondary schools. Similarly with EMA Type 2, most schools in this Type have only two to three programs. Secondary schools are an exception. Here, the number of programs per school is bi-modally distributed: 10% of schools in EMA Type 2 with 2-4 programs and between 10-11% with 6-10 programs.

Of the schools using just two to three programs, one program is highly likely to be User Group (EMA category T), thus reducing the range of programs actually in use down to 1 or 2 for most schools in EMA Type 2: 30%, 23%, 10% and 27% respectively across primary, intermediate, secondary and area school types.

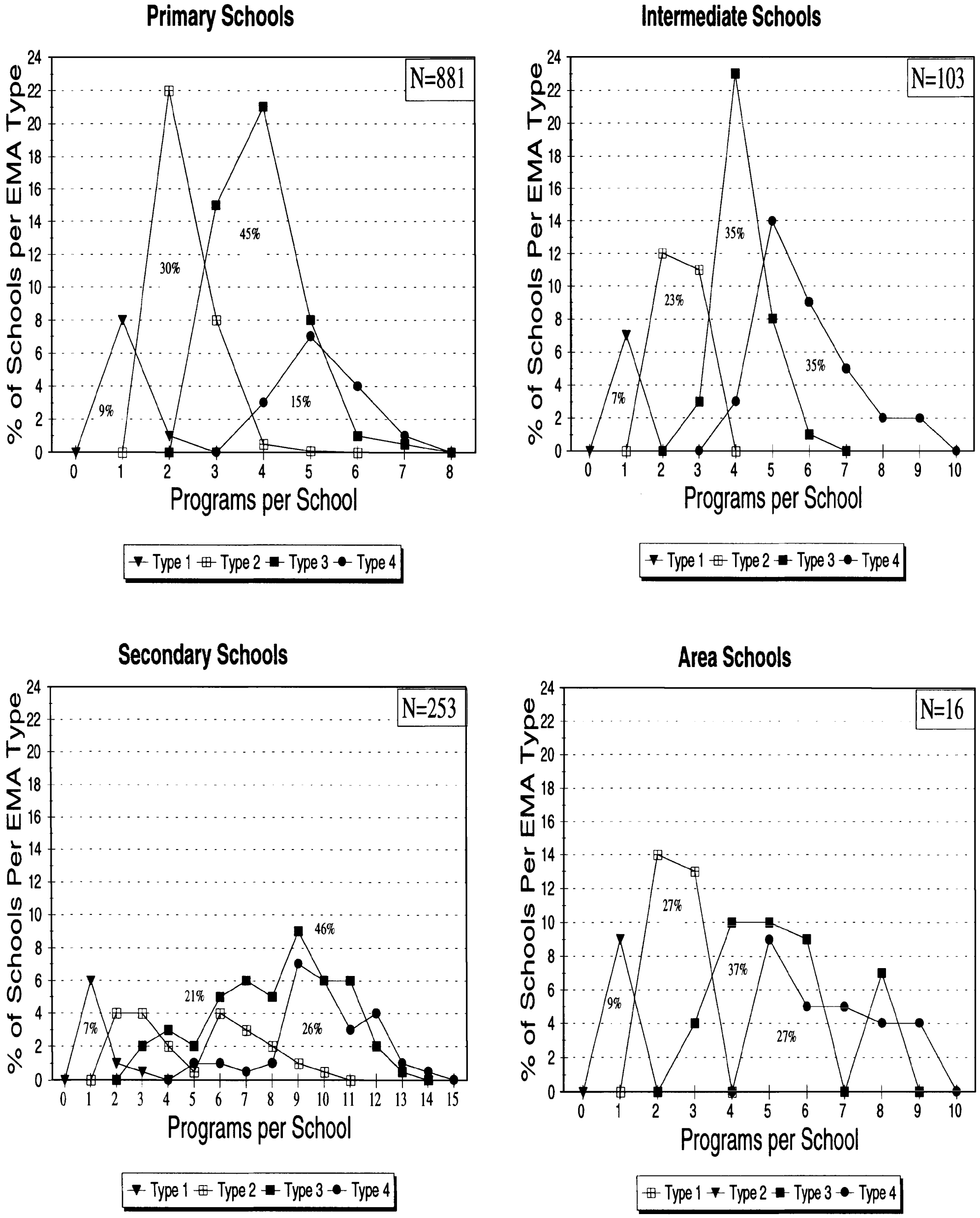
These figures suggest that the percentages for EMA Types 1 and 2 should be combined so as to reflect what amounts to a relatively limited use of administrative software by a fairly large minority of schools from all four school types: primary = 40%; intermediate = 30%; secondary = 18% down from 28%; and area = 36%. That is to say, more than a quarter of all primary, intermediate and area schools have a relatively restricted use pattern across EMA types 1 and 2. In each case, there is scope for further development with CASA.

The general pattern for EMA Type 3 indicates a solid core of schools across all school types with an apparently more extensive use of administrative programs: primary = 45% with 3-7 programs/school; intermediate = 35% with 3-6 programs/school; secondary = 46% with 3-13 programs/school; and area = 37% with 3-8 programs/school.

At the EMA Type 4 end of the spectrum, differences between school types become accentuated, signified by the changing shape of the area graphs. The relatively flat secondary graphs and elongated intermediate, and to a lesser extent primary and area school graphs suggests a different kind of use pattern, signalled earlier but not explained by the cumulative percentages in Table 3 and the line graphs in Diagram 1.

The pattern is best illustrated and best understood by a comparison of intermediate and secondary schools across EMA Types 3 and 4. The fact that 70% of all intermediate schools fall in these two types (35% in each Type, with 10% and 9% more respectively than secondary and area schools in EMA Type 4), but use only 4 to 9 programs, indicates a policy of supporting the

## Diagram 4: Percentage of Schools by Programs per School for Each School Type


Primary Schools

Intermediate Schools

Secondary Schools

Area Schools

full range of management and administration functions but with only a core of 1 to 2 programs for each function. In contrast, the fact that 72% of secondary schools in EMA Types 3 and 4 (with 46% in EMA Type 3) use between 5 and 14 programs suggests a policy of in-depth specialist use across a narrower band of management and administration functions. Perhaps these specific differences reflect a larger difference between an integrated-holistic approach to school management and administration at the intermediate level versus a compartmentalised-functional approach at the secondary level.

Overall, the relatively large percentages of schools from all four school types falling into EMA Types 3 and 4 (primary = 60%; intermediate = 70%; secondary = 72% and area = 64%), indicates that computer assisted school administration is well established in the New Zealand school system.

## 5. CONCLUSIONS

In summary, the findings indicate that the majority of MUSAC-using schools could be classified as "adult to mature users" of educational management and administration (EMA) software, although a significant minority across all school types is still at a neophyte stage. Within MUSAC-using schools as a whole, differences in use patterns may reflect different administrative requirements and different styles between school types as much as it does levels of sophistication in the use of specific programs. The differences warrant further investigation in order to better understand, and control, the direction and dynamics of computer assisted school administration in New Zealand. Such investigation might be in the form of a national survey to establish what software is actually being used in schools, case studies to record exemplary CASA practices and qualitative studies to document the level and nature of administrative software use. To this end, the approach to research presented here using EMA concepts might be of value in conducting further, perhaps more in-depth, comparative analysis of use patterns between school types.

Research into levels of use seems a logical next step in order to paint a fuller picture of the manner in which schools are using computer technology in support of school management and administration functions. Anecdotal feedback from the MUSAC Help Desk, MUSAC training seminars and school administrators doing post-graduate work, suggests that there is considerable variation in levels of use. For example, while quite a lot of secondary schools use administrative software to carry out higher order management functions (e.g. strategic planning), an equal number use it simply to generate timetables and class lists and issue parents with school accounts. Interestingly, a small but significant number of primary and intermediate schools use their somewhat fewer computer resources to make key data about the school (e.g. details of the school budget) available to the whole staff as the basis for collaborative problem solving and shared decision making. This approach appears not to be well understood in secondary schools and is, therefore, seldom used.

In the past, school inspectors and the school advisory service played a role disseminating good ideas and effective educational and administrative practices. In New Zealand's school system today, this role is now performed by periodic Ministry of Education school development contracts, delivered by various professional agencies and organisations in the community. Such contracts, if let in the general area of computer assisted school administration, could build upon the findings of this and subsequent research by funding programmes within which knowledgeable and experienced educational practitioners might help less experienced schools avoid pitfalls and pursue beneficial development paths. This could be an effective means of demonstrating how information sharing and collaboration between schools (as distinct from insularity and isolation) empower schools to get the best value from their administrative computing resources.

Irrespective of what happens, MUSAC will continue to play a dominant role as New Zealand's only university-based enterprise providing affordable, competent and user-friendly administration software that New Zealand schools require. The location of MUSAC in a university provides the software developers with three specific freedoms apparently important to the success of the enterprise: (i) freedom to exercise control over (and accept responsibility for) the manner and direction in which school administration software is designed; (ii) freedom to promote educational interests by adopting a "school-centred" approach which places control over school management in the hands of school personnel; and (iii) freedom to exercise discretion in deciding from whom advice and support might be sought (e.g. schools, government, business) and ultimately accepted or rejected.

The exercise of these freedoms entails that the developers pursue their objectives in a way that is consistent with knowledge creation and research values which define the mission of a university and set it apart from the institutions and organisations of government and business. On the one hand the developer's role is to produce software that is technically competent. They are well placed to do this in the University through having ready access to the latest technical knowledge. On the other hand, their role is to encourage innovative school management by designing school administration software which incorporates the latest ideas from educational management theory and research. In respect to this aspect of the role, MUSAC staff are able to interact, and exchange ideas, with Education Faculty members and Educational Research and Development Centre staff actively working in the field of educational management and administration theory and research.

In terms of its distinctive character as a "grass roots" enterprise, MUSAC offers an alternative to the way in which computer assisted school administration has been developed elsewhere. No claim is being made here that one approach is better than another. It is important to note, however, that the combination of being university-based and "grass roots" predisposes MUSAC to be flexible, proactive and responsive. These attributes may be more difficult to achieve in school systems which have adopted a top-down, centralised approach. The former permits software designers to meet the needs of schools as their first priority. Importantly, it also leaves them free to incorporate features which enable schools to meet the requirements of external authorities, e.g. the Ministry of Education, which specify the broad parameters within which schools are mandated to educate the youth of the Nation.

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# 10

## School Management Information System Authority in Israel

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### Abstract

The management of Israel's educational system entails the involvement of several entities - the Ministry of Education, local authorities, schools, training institutions, etc. - in terms of operation and responsibility. This is a system with a wide geographical distribution, which affects the country's entire population.

In order to overcome the complex and problematic nature of information in educational systems, it is necessary to enable integration and compatibility of the various systems, while at the same time leading to improvement of management and decision-making processes.

The end unit of this system is the SMIS - School Management Information System. The objective of the SMIS is to improve administrative and pedagogic management and decision-making processes in schools by:

- Compiling and analyzing data
- Locating and displaying exceptional cases
- Increasing efficiency and reducing the administrative burden
- Providing tools to assist in the administrative and pedagogic decision-making process

Moreover, SMIS aims to link the school information system to the Ministry of Education and external information systems to constitute an infrastructure database enabling data flow in all school information systems.

Keyword Codes: K.3.1; K.4.3; K.6.1
Keywords: Computer uses in Education; Organizational impacts; Governmental issues; project and People Management.

### 1. BACKGROUND

The changes in information technology, i.e. miniaturization, reduced costs, simplification of use and maintenance, user friendliness and communicative effectiveness have led to a rapid development of school information systems. The importance of SMIS is greater in schools than in other organizations because of the uncertainty level in school management [1]. The more people recognize the benefits of information technology, the more aware they become of the need to adapt organizations and their administration to advanced technological methods.

## 2. SMIS OBJECTIVES

The objective of SMIS is to improve administrative and pedagogic management and decision making processes in school. The school generates and uses data derived from such sources as parents, teachers, educational authorities and of course pupils. As the quantity of data is enormous, it is essential to have a tool to compile and to analyze data. When data is analyzed it is possible to locate and display exceptional cases. The IT provides tools to assist in the administrative and pedagogic decision making process. It increases efficiency and reduces the administrative burden. The build up of an infrastructural data base enables data to flow in all school information systems and enables linkage among school of Education, and other external information systems.

## 3. SMIS AUTHORITY

In 1989, the Ministry of Education initiated the SMIS project and the SMIS authority was established [2]. The SMIS authority is functioning as a "National Operations Center", to guide and monitor SMIS development and implementation. Its main functions and areas of responsibilities are: (a) development and maintenance of a standardization file, establishing a common data dictionary for all schools and software developers, supervising the software suppliers; (b) development and maintenance of a training course array; (c) development and maintenance of professional guidance array; (d) communication and contacts with other educational systems, local authorities and governmental authorities; (e) support and consultation; establishing an information center, assisting in implementation and integration of all factors in and out of schools.

## 4. STANDARDIZATION FILE

The standards for the software elements [3] - data, files, interface, etc.- are compiled into a dynamic file updated according to needs arising from procedures, feedback from schools and users, and requirements from the Ministry of Education. The file is updated twice a year followed by an implementation check-up.

The standardization file main parts are: (a) a basic system with basic modules for the school level system, and (b) guidelines for supplier services and maintenance.

### 4.1 Basic Modules for SMIS Systems

SMIS was developed as a platform software, i.e., a basic software kernel to which various modular components can be appended after acquiring the basic "MANBAS" (as SMIS is known in Israel) software. Each school can supplement it with add-on in a variety and formats suiting its needs and budget.

The basic software comprises the following modules:

Student data management
Teacher management
Subject management
Achievement recording and report
Pedagogic module - statistical analysis and reports

The guiding principle of standardization is that any software (besides the SMIS) to be added to the school in future will obtain student and teacher data from the basic system.

Besides the above mentioned modules, there also add-on modules, i.e., self-evaluation system, curriculum and teaching aid management, bookkeeping, library-management, etc.

### 4.2. Guidelines for Supplier Service and Maintenance

A very important part of the standardization file is the module for guidelines and maintenance. It describes the methods for services and maintenance of procedures and software. It comprises the following subjects: (a) individual operational instruction in schools, provided in stages in accordance with the present stage of the school, (b)service and maintenance for hardware and software, and (c) software version updates.

To date, five software suppliers have received a franchise to operate the software in schools. The SMIS Authority maintains a control array on SMIS suppliers in all areas pertaining to application of standardization, compliance with standards and service levels, as well as handling incoming complaints from schools. If any SMIS supplier does not comply with the conditions stated above, the Ministry of Education can revoke its franchise for the sale of software.

## 5. SMIS SEMINARS

The SMIS authority performs a large training activity throughout the country. The training activity is divided into two major types: (a) seminars, (b) training and consultancy.

The seminars aim to cover SMIS introduction to the school management staff: principals and SMIS - coordinators on one hand and on the other hand to introduce and train SMIS school secretaries [4,5,6,7]. A 40-hours course was offered for the school management staff, and a 20 hours course for the secretarial staff.

The School's head - master attitude to SMIS implementation and its integration into school routine is extremely important, therefore the emphasis in the seminars is on these matters.

The objectives of the seminars are;

(1) Preparation of the background for receiving the SMIS
(2) Recognition of its necessity
(3) Training of functionaries
(4) Developing skills in the use of SMIS reports
(5) Increasing the efficiency of the decision-making process on the administrative and pedagogic level

The seminars' syllabus [8] includes: computerized information systems, introduction of modifications to the Protection of Privacy Law,, statistical concepts, introduction to SMIS products and their use, word processing, inculcation of additional skills - familiarization with the computer and experience with the software purchased by the relevant local authority. Seminars are administered within the region, on the basis of an agreement between the Ministry and the local authority. Each course consists of several sessions; each session includes lectures, workshops and practice.

SMIS courses and seminars are being given, initially to school principals and coordinators on one hand, and to school secretaries on the other, parallel to the introduction of the systems into schools. At a later stage, the objective is to instruct all teachers by means of institution-wide courses.

In view of the more widespread use of SMIS systems in schools within outlying settlements and the need for courses throughout Israel, it has been decided to expand the course frameworks to colleges and institutional entities. In order for those entities to benefit from the total experience accumulated by the SMIS authority, an Instruction Kit has been developed. The Instruction Kit includes a Lecturer's Workbook and a Student's Workbook (Manbas Authority 1992). The first contains a lesson plan, a detailed listing of lectures, and transparencies, while the second contains transparencies of the lectures with explanations and space for the student's comments.

## 6. GUIDANCE AND IMPLEMENTATION

The true test of the SMIS is its implementation or even assimilation- i.e., the use of its output in administrative and pedagogic decision-making, and its transformation into a vital and integral part of the school.

Introduction of SMIS systems into the schools is backed by close individual guidance. Internalization of the system into the school is affected to no small degree by the quality of guidance provided. For this reason, great resources and efforts are invested in guidance, and in the training and operation of a skilled team of consultants.

The role of the consultant in the implementation set-up is a crucial one. In some places, where guidance was not provided, the system stopped functioning after a while, or the tool was not used beyond producing students and teachers lists.

The consultant's role starts even before the installation of the computerized system in school. His task is to diagnose the stage of the absorption process of a school, in cooperation with the school principal. Together they build a plan of operation including written goals and timetable. The consultant supports the principal, helps-out the school SMIS coordinator in the initial stages, and teaches staff in subsequent stages by means of consultancy and advice in finding solutions. In many cases the consultant is liasing among the entities involved in operating SMIS, i.e., local department of education, suppliers, etc.

The consultant must provide encouragement and consultancy for the administrative/pedagogic staff, must acquaint them with the wide range of possibilities and options for use of the tool, and allow them to benefit from his experience. The consultant does not decide for the school; decisions are made by school functionaries.

The SMIS authority operates and supervises some 50 consultants. Some of these are employed by the local authorities, and others by the SMIS authority. All of the guidance activities, down to the most individual level, are reported to the SMIS authority through consultant's reports and input into the database for follow-up and control and problem solving. The data base comprises information of the degree of internalization. The SMIS authority, supports the local authorities. In order to do this the authority maintains a support center to which any question concerning the SMIS may be addressed - from requests for guidance in operating the software, through complaints against suppliers, and up to wishes for software development. The authority initiates activities to encourage the use of the SMIS, such as the publication of booklets and information sheets and organizing conferences. It moreover initiates study days on special subjects requiring intensive guidance and briefing, such as self-evaluation (computerized examinations), student roster, etc.

A procedure was established for the implementation of SMIS. This procedure contains mile-stones for monitoring the implementation process.

The first step in the implementation process is setting up a student file this is done either by keying-in the computer data from existing forms or by transferring a file from the local authority or from the ministry. In any event, data are checked and verified. A parallel step is setting up a teacher file which is done more or less in the same way as the student-file. Next step is the assignment to homeroom classes and study groups and setting up subject tables. The products of these stages are usually variou lists of students and teachers and other reports deriving from the student and teacher data-base, some schools implement the discipline and attendance module and sent reports to the parents.

The following step, which is regarded, as major step forward is the implementation of the pedagogic module. This step includes keying-in grades: term grades, test/term paper grades. Some schools enter this stage by starting to key-in grades of particular subjects throughout school, other gather grades of particular classes. Most schools begin by keying-in term grades in order to produce report cards. In the advance stages a school generates statistical reports which are used by the school principal, teachers, and pedagogic council.

System operation is implemented by the schools on an ongoing basis and includes: generation of output at various levels (from lists to complex processing),ongoing update of data (student and teacher particulars, changes in assignment to study groups), input of data (grades, attendance, and discipline).

## 7. THE SURVEY

A survey was conducted in 1993 and 1994. The 1994 survey was done in two independent formats: data were gathered from consultants reports and questionnaires were sent out to schools. In both cases the results are similar (but not yet fully analyzed).

It is important to notify that the sample is taken from schools based in townships which signed a contract with the SMIS authority. Those schools receive guidance and are supported by the SMIS authority. The schools are from townships in all districts and represent the Jewish and Arab sectors.

Population: 349 schools :

| **Implementation stage** | **% of Sample** |
|---|---|
| Internalization of administrative module | **98%** |
| Use of report generator | 77% |
| Use of pedagogic part | **61%** |
| Use analysis of statistical reports for pedagogic purposes | **42%** |
| Generate computerized report cards | **40%** |

## 8. CONTRACT WITH THE LOCAL EDUCATION AUTHORITIES

The Ministry of Education assists local educational authorities who are adopting a township-wide course of action for introduction of SMIS systems into their schools. This assistance covers about 1/3 of the cost of a SMIS Kit which consists of:

- Hardware (computer and printer)
- Software (including maintenance and update)
- SMIS courses for functionaries
- Guidance
- Setup and ongoing operation

Following is the order of activities undertaken upon agreement between the local authority and the Ministry for township-wide deployment:

- Purchase of hardware and software
- Courses for administrative functionaries

- Guidance backing the setup and ongoing operation
- Institution-wide courses for the teaching staff

By the beginning of the 1993/94 school year, more than 1,400 schools in some 120 local educational authorities throughout Israel had joined the project. Some 60 schools defined as "leading" schools were given increased assistance and were earmarked as demonstration sites for application of the SMIS and as experimental test grounds for new versions of hardware and software,

## 9. CONCLUSION

The School Management Information System improved the handling of information in schools as well as in the Ministry of Education and other educational authorities.

The SMIS authority acts as a coordinator among all existing educational authorities. As there are many of them it is crucial to have an independent body in order to control and coordinate all units involved.

The overall immediate response gives the school an incentive to implement further computerized processes. The ongoing dialogue among the units concerned has improved the quality of data retrieval and management information systems all around.

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# 11

## The Development of ITEM in England and Wales

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### Abstract

In the United Kingdom the early 1970's saw the introduction of teaching about computers, the early 1980's the use of computers to enhance teaching and learning, and the early 1990's have witnessed the wide scale introduction of Information Technology in Educational Management (ITEM). The first part of this paper examines briefly the impetus behind the broad adoption of ITEM in England and Wales. The major part of the paper reports on a survey of Local Education Authorities (LEAs) in England and Wales. Statistics are presented which demonstrate the comprehensive take up of ITEM over a short period of time. How projects were co-ordinated; what applications were being run, and what proprietary systems were chosen; the hardware used; the level of training and support provided for schools implementing and running ITEM systems, are all discussed.

Keyword Codes: C.5.3, H.4, K.3.1
Keywords: Microcomputers; Information Systems Applications; Computer Uses in Education.

### 1. BACKGROUND

Even before microcomputers were first introduced into schools in the United Kingdom the computerisation of many aspects of school administration had been proceeding in a piecemeal manner for over twenty years [1]. However, in 1988 the Government of the United Kingdom passed the Educational Reform Act (ERA) [2], this one piece of legislation has resulted in massive changes to the way in which education is organised and managed within England and Wales. One of the major features of the ERA was the compulsion on LEAs to delegate much of their managerial and financial powers to schools, this lead to what has become known as LMS (Local Management of Schools).

Whilst there was no compulsion within the ERA for schools to introduce ITEM the implications of the Act are such that its introduction seemed inevitable. The Coopers and Lybrand report on LMS [3] had suggested that schools would need computer-based management information systems, this was followed by the Department of Education and Science's (DES) Circular 7/88 [4] which again identified this need. In the same month the government announced its intention to offer Education Support Grants (ESG) [5] totalling £25 million over the three year period commencing April 1989 for: introducing appropriate information systems into all schools with delegated budgets; setting up LEA support teams to assist with this activity; training of relevant school staff. ESG grants were subsequently increased and extended in this area. The stage was set for the co-ordinated and massive introduction of ITEM into schools within England and Wales.

## 2. METHODOLOGY

The content of this paper is derived from a number of sources. The two major instruments were questionnaires addressed to Local Education Authorities in England and Wales. The first survey was undertaken by the Local Authority Management Services and Computer Committee (LAMSAC) in 1989, and the results published [6]. In 1991/92 I decided to carry out a follow-up survey to obtain an overview of how much progress had been made in the intervening period. LAMSAC no longer existed, so I obtained permission from the Local Government Training Board, who had taken over some of LAMSAC's roles, to replicate the earlier study, thus allowing direct comparisons of data collected. Minor amendments were made to the content of the questionnaire to simplify the respondents task, and also to obtain some extra data concerning training and support. Further data and information has been drawn from a variety of sources including Department for Education (DFE) (formerly the DES) publications.

### 2.1. Objectives

The main focus of both surveys was on the proprietary systems used by schools for administration purposes. The two questionnaires were designed to ascertain a wide range of information including:-

- Numbers and types of schools with live computer administration systems;
- Which proprietary packages were being used, and which had been trialled and rejected together with some subjective views of the packages;
- What applications were being run;
- How the LEAs had chosen the software;
- How progress was being monitored and controlled;
- What hardware was being used to run the systems;
- Training and support offered to schools running systems;

### 2.2. Respondents

Ideally, systems managers and/or headteachers in all schools in England and Wales would have been targeted, but LAMSAC had, in planning their original survey, decided to address the questions to LEAs for reasons of economics and relating to problems of chasing and evaluating responses,

> "Specifically it was accepted that:
> - The evaluation by LEAs of the grass-roots value of schools systems would be based on second-hand information in many cases;
> - LEAs may not necessarily know of systems being developed independently or in-house by schools in their area;
> - The opinions of LEAs of the value of authority-wide standard selections of software may not be consistent from area to area;

> - Non-returned questionnaires are difficult to trace in a large local authority department.
>
> However, all these reservations apart, LEAs are in by far the best position to give objective and balanced views of the activities of their schools." [6, page 6]

As LAMSAC had adopted the approach of targeting LEAs I felt obliged to adopt the same approach and echo their reservations relating to it.

### 2.3. Questionnaire Design

The LAMSAC questionnaire was divided into four parts: one mandatory and three optional parts relating to the stage of implementation of ITEM that each authority had reached (Computers installed and running live systems, actively planning to introduce computers, no plans). However, as I felt that considerable progress should have been made in the intervening period, the follow-up questionnaire consisted only of two sections. The first section of the questionnaire was designed to obtain a general picture of the LEA whilst the second section, based on LAMSAC's section B, concerned the implementation of ITEM in the LEAs' schools.

## 3. RESULTS

In the following I will discuss predominantly the findings of the follow-up survey, however these findings will be compared to those of LAMSAC, and others where data is available.

### 3.1. Response rate

The LAMSAC survey achieved a 61% response rate from the 104 addressees, whilst my questionnaire attained a 53% response from 119 addressees, the variation in number of addresses being accounted for by the intervening break up of the Inner London Education Authority (ILEA). Though both response rates are not high the two surveys achieved a good representative spread of the various types of LEAs in England and Wales, and the base of both surveys is approximately a 50% sample of all schools. The LAMSAC survey covered 16,775 schools, of which 13% were secondary whilst the follow-up covered 13,839 schools of which 14% were secondary.

### 3.2. Co-ordination of projects

Predictably, most LEAs, had set up some sort of working or steering group to advise, control and monitor the introduction of ITEM. The structure of these groups varied, as did their titles, powers and prime area of concern. The groups normally included education officers, LEA information technology officers and co-opted school heads, some LEAs had included union representation, and representatives of school based secretarial staff, though the number reporting both of these were low. The prime concern of a significant number of these groups was the introduction of Local Management of Schools (LMS) and they had the also been given the responsibility of co-ordinating developments in ITEM. Project teams had been set up by a third the responding LEAs and these had taken on the role of implementing and monitoring the project either jointly with the working group but more often than not replacing it. Most LEAs had set up a support team, a subject which will be dealt with in more detail later, and these teams had in many instances taken on the role of implementing and monitoring the project either jointly with the working group or by replacing it. User groups were reported as being set up and used in the co-ordination, implementation and monitoring process in fourteen LEAs.

### 3.3. Special Problems

One opened question was concerned with special problems associated with introducing computers for school administration across the LEA. The variety of problems mentioned was nearly as great as the number of respondents. However, significant numbers of LEAs highlighted the training of school based staff, noting such issues as costs and quality of training, availability of staff for training, including time to practice the skills taught on courses, and time scales for training (and implementation).

A second significant group of problems involved the logistics of visiting schools to install, support and upgrade systems. The major concern here related to the size and cost of the team required to adequately support the initiative, the problem being exacerbated in the larger rural authorities which tended to have large numbers of small schools spread over a large geographical area. The financial problem for these geographically larger authorities was added to in some cases by having to set up and staff two training centres in different parts of the authority. Small schools also create an interesting problem in that they physically may not have the space to install systems. Five authorities claimed not to have had any problems, due to the consultation procedures they had undertaken

The problems previously noted by the LAMSAC survey of schools being resistant to standardisation and the need for cheaper and easier communications were only noted by four and one authorities respectively in the follow-up.

### 3.4. Requirements for Outside Help and Information

In response to my question "Are there any areas in which you would like some outside help or advice? What sort of assistance would be most appropriate?" Twenty-five LEAs responded - "No", and seven felt they needed help with funding. A wide range of requirements for outside help had been noted by LAMSAC. However, possibly due to the publication of 'Computer-based administration systems in schools' [6] which may have met many of the LEAs requirements regarding information , or presumably having gained three years experience, LEAs seemed to feel that they had either solved their problems or had found the outside help they required. A general interest was shown by many respondents in finding out about the experiences of other LEAs, especially relating to training, support, and networking.

### 3.5. Installed Systems

In response to the questions concerning live computer administration systems. The following information was obtained.

Table 1
Installed systems.

| | Sept. 1988 | July 1989 (Predicted) | Feb. 1992 | July 1992 (Predicted) |
|---|---|---|---|---|
| Primary | 3% | 7% | 41% | 67% |
| Middle | 11% | 23% | 69% | 88% |
| Secondary | 46% | 70% | 98% | 99% |

Over the period covered by the two surveys it can be clearly seen that significant progress in terms of live systems installed was made. Primary schools appear to be trailing considerably. The major reason for this is, initially primary schools with less than 200 pupils were excluded from LMS schemes [2] and therefore were not included in schemes to introduce computerised administration systems into schools. However, in noting this trend in 1989 LAMSAC [6] claimed

> " the rate of implementation of new administrative systems in primary schools is likely in future to be very much higher: systems are simpler and much of the pattern of administrative computing will already have been set by secondary school installations; and the major problems will have been identified." [page 10]

A somewhat over simplistic view. There are over six times as many primary schools as there are secondary schools represented in these two surveys; systems until very recently have not been developed with primary schools in mind; and primary schools need not have the same range of problems as secondary. Responses discussed later bear out some of these suggestions.

### 3.6. Installed Applications

The LAMSAC questionnaire next examined in some detail the applications that had been implemented by each school. In designing my questionnaire and having the benefit of seeing the results obtained by LAMSAC I made the decision not to gather specific information on each of the main areas of application, but to allow respondents to give detailed information if they felt so inclined, few did. The reasons for this approach were: that the schools were not answering the questions; and any answers gathered would rely on the respondents interpretation of the activity in the LEAs schools. This concern over the accuracy of the perceptions of LEA respondents in this area is possibly justified when one compares the following table with DFE statistics, included in brackets, collected directly from a sample of schools in March 1989. [7]

Table 2
Summary of Installed Applications

| | Primary<br>% | Middle<br>% | Secondary<br>% |
|---|---|---|---|
| Accounting | 68 (61) | 82 | 93 (95) |
| Timetabling | 4 (4) | 18 | 43 (64) |
| Pupil Records | 88 (44) | 98 | 99 (84) |
| Staff Records | 70 (26) | 69 | 87 (69) |
| Word Processing. | 92 (82) | 98 | 95 (100) |

% responding based on number of schools reporting live systems

The results shown above are in no way surprising, one would expect word processing to be the most widely used application, pupil record systems tend to be at the centre of all the modular integrated packages available within the UK, and with the emphasis on LMS accounting is bound to be a high priority. The differences in the two sets of figures can be accounted for: The variation in the numbers of secondary schools reporting timetabling is used is probably due to the fact that there are a number of packages that can be purchased, for a variety of timetabling tasks, that schools have probably bought for themselves. The DFE question concerning pupil records also included assessment. Staff records in primary schools may well be seen as a low priority compared with finance and pupil records, and primary schools are at an earlier stage of development.

### 3.7. Uptake of Proprietary Software Systems

There were two clear market leaders. SIMS, used by 81% of primary schools and 78% of secondary schools, and SCRIPT with 10% and 8% respectively. This left a very small market share for the other products which were in the main in-house LEA systems though some of these may be purchased, indeed both SIMS and SCRIPT started as in-house LEA systems. It should be noted that very few LEA's adopted a mixed economy i.e. using different systems for primary and secondary. This is very healthy situation for SIMS but I am not so sure it is for ITEM in the UK. It may be that the figures given here are not a true representation as the responses are made by LEAs and therefore they may be unaware of systems purchased by schools, but the majority of schools are still LEA maintained and standardisation of reporting procedures necessitates to a very high degree the standardisation of software across each LEA. LEAs were asked to supply details of proprietary systems that they had considered. Most had considered the two market leaders, but significant numbers had also considered other packages and rejected them for a variety of reasons both commercial and operational. A surprisingly small number had considered the Scottish market leader SCAMP. It would possibly be unfair to report on the perceived strengths and weaknesses of individual proprietary systems here as most systems have undergone further development since the data was gathered. However, general points that were considered important include:

- single entry integrated software is a must;
- user friendly;
- offer facilities required by DES. (e.g. see [8])
- size of user base of the proprietary system. Concerns here were two fold: if the system had a small user base the supplier might not be financially secure, if the package had a large user base how well could this be supported;
- systems suitable for secondary schools were not necessarily suitable for primary schools;
- school based PC systems should be capable of being linked to LEA mainframe to facilitate two-way transfer of data;
- flexible report writer;

### 3.8. Hardware

The picture regarding the type of hardware used by schools obviously must reflect the choice of software. The LAMSAC survey found both the average primary and secondary school with live systems were using single-user IBM compatible computers running under MS-DOS. However, the follow-up survey found that whilst the situation had not changed greatly regarding primary schools, over 70% of middle and secondary schools were using Local Area Networks with significant numbers being connected to Wide Area Networks. Other significant differences between the two surveys with respect to hardware were the unsurprising shift from daisywheel printers to laser printers, dot matrix/ink jet printers were still widely used, possibly due to their price and/or ability to print on wider paper than laser printers. Large numbers of schools both primary and secondary were now equipped with modems, and a significant trend towards the introduction of document readers was apparent.

### 3.9. Consultation, Training and Support

Three questions were asked concerning the above in the follow-up survey that were not asked in the original survey. In response to the question "Were schools consulted prior to the purchase of systems for administrative use?" six LEAs responded "No", all other LEAs involved schools by running pilot schemes or having representatives on working groups, although in some cases only secondary schools were involved in pilot schemes and working groups. In most cases representation on working groups was minimal. In only one case did an LEA claim to consult all the schools within its area. This lack of consultation must mean that systems were introduced into schools without the school examining its information needs, and identifying how computerisation might benefit them.

Training of school staff, both academic and support, was provided when systems were first installed and was normally undertaken by the LEAs own staff, however, six LEAs bought in external contractors. The number of staff trained from each school, the amount of training given, and the way in which it was delivered varied considerably. Most LEAs had opted to train three people per secondary school (the headteacher, and/or deputy, and/or the systems manager, and a secretary), and two people per primary school (the headteacher, and the secretary). Training tended to focus on how to operate the hardware and software. The general pattern for training included time spent on word processing, and time spent on the adopted proprietary package. Quite often the headteacher and secretary were trained at the same time. The split between those authorities who gave the training in a block and those who spread it out over a period of time, with many breaking it down into half day sessions, was very nearly equal. Length of training varied considerably with some LEAs reporting as much as 10 days per secretary, others only 3 days. The mean per secondary school was 6 days training for 3 people, and primary schools received on average 4 days for two people.

Once systems were installed most authorities continued to support schools in a number of different ways. Most LEAs reported setting up support teams to carry out some or all of the following functions: initial installation of hardware and software; updating of software on school systems; supply further training; provide telephone hot-line support; hold surgeries; and give field support to schools. Support teams were often divided into trainers, hardware support, and software support. User groups and regular mailings including newsletters were cited as additional methods employed to support schools.

### 3.10. Future requirements

The major concern expressed here related to the ability of systems to cope with the financial side of LMS, which is not surprising as most of the systems were originally developed prior to the ERA. However once again, the producers of the proprietary systems have in general responded and produced/modified modules that meet the demands. Other future requirements specified included: simpler systems for primary schools; improved analysis and reporting facilities; improved data transfer facilities between LEA and schools; registration/attendance module; easier correction of errors; easier transfer of data between modules; and a system that runs under Windows.

## 4. CONCLUSIONS AND RESERVATIONS

Government legislation and initiatives have led LEAs into wide scale implementation of ITEM systems. Under LMS schools needed computerised management systems in order to take on some of the roles formerly covered by LEAs, and schools now have systems running a range of applications including accounting, pupil records and assessment, staff records, word processing and timetabling.

Systems were introduced at a time of great educational change and it may well be that the changes could not have taken place without computers. However:

- as systems were largely introduced without, what I believe to be, adequate consultation, it may well be that implementation has not been as smooth as it should have been;.
- systems were generally installed at school level ignoring the best practice of systems analysis and implementation from commerce and industry;
- senior management in schools do not appear to have received adequate training in how the systems can be best used to construct a picture of their schools performance, and plan for the future by displaying current trends and modelling different scenario;
- the numbers of machines installed under government/LEA funding are possibly inadequate to directly impinge on classroom teachers;
- software needs to be continually developed to meet the needs of schools (including primary schools), LEAs and the DFE - a Windows environment appears to be a necessity when most new word processors use this system;

> "...schools now require help with using their MIS in a more proactive and integrated way, which will not only reduce administrative tasks for teaching staff, but will also support future planning, act as a diagnostic tool for school analysis and evaluation and finally help schools promote themselves in the increasingly competitive education market." [9]

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# 12

# Information Technology in Educational Management of Nepal

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## Abstract

This paper is divided into two parts. First the introduction touches very briefly on the geographical, economical and social status and use of computers in Nepal. The second part of the paper attempts to describes the use of Information Technology (IT) and its impact on the management of the secondary school, universities and Ministry of Education of Nepal. In conclusion, Nepal's policies regarding the use of information technology (IT) are presented.

Key Codes: H2.4; H3.3; J.6; K6.1
Keyword: Database Management System; Information Search and Retrieval; Computer -Aided Engineering; Project and People Management.

## 1. INTRODUCTION

Nepal is a mountainous country . It is a landlocked and sandwiched between the two large nations China in the north and India in the south, east and west. It is rectangular in shape with 147,181 sq. km of land in area. Of the total land area, about 78% is covered by snow mountains, high hills in the north and middle part of the country. Most of the flat lands lie in the southern part of the country. Nepal is predominantly an agricultural country. The cultivated land area is about 18% (36,535 sq. km.) of the total land area. The population of Nepal is 18.5 million. Life expectancy at birth is 54.6 years. The literacy rate of Nepal is very low, it is only 39.6 % and per capita income is US $ 170.00 per annum.

## 2. USE OF COMPUTERS IN NEPAL

### 2.1. Computer in Nepal

Nepal first introduced computer technology in 1971, in connection with the processing of national population census data. IBM 1401, the second generation and medium sized mainframe computer, was used for data processing, table printing, statistical calculations, etc., of the population census. Only in 1984, the microcomputer was introduced in Kathmandu, Nepal. Since then the use of computers has been gradually increasing. At present, every government department and ministry in Nepal has been makes use of microcomputers. However, they still lack skilled manpower, and proper computer knowledge for using microcomputers according to their need. At the movement this technology (IT) is being used with middle level and low level manpower, to some extent. Similarly, in business, hotels, banks, airlines, travel agencies, some private boarding schools and campuses are being used microcomputers. Till now, the universities in Nepal have not introduced computer courses as such in the diploma and degree level although computers have already been used for management purposes. Very few campuses of the Kathmandu valley have started computer classes which take the form of an optional course or extra activities. In the Nepali economy, the demand for the skilled manpower is growing day by day. On the other hand highly skilled manpower in this field is leaving the country for better opportunities. The Nepalese computer working environment is not yet good enough. There is ample scope for improvement in this field. To improving management so as to satisfy customers and to upgrade the quality of work, the use of computer is being increased as far as possible.

### 2.2. Devanagari Script

In 1988, software experts of Nepal developed Nepali script ( Devanagari script) which can be used only in Macintosh . Only 10 percent of machines could be covered by this type of development. Now, by using windows package, in 1993 they have managed to develop Devanagari script in ASCII code for IBM compatible micro computers. This has increased the coverage to all types of computers having word processing facilitated. This has led to considerable increase in the number of desktop publishing houses, specially in Kathmandu. This has facilities such works as report writing, printing, preparation of data base, mailing list etc. The Ministry of Education, universities, schools and libraries are increasingly using this script making use of PC's.

## 3. IT IN SCHOOL MANAGEMENT

As per 1992 education statistics, there are 19,498 primary, 4,230 middle and 2,309 secondary schools , where altogether 38,89,847 students are pursuing studies. Of these, there are about 800 boarding schools . About 50 of these boarding schools are providing education on computer subjects .Eleven of these boarding schools have been making use of micro computers for school management. The educational management activities include student and teacher's record keeping , research and development, examination result processing, question and answer designing, mailing list storing , account keeping, word processing, secretarial service, etc.

At Kathmandu, there are more than ten small private software houses. Among them three have prepared educational package, which contains student record keeping, pay roll, examination result processing, quarterly and yearly student evaluation, quiz boxes, etc. . At cheap price they are selling it in some schools. The buyer school have started using it .

## 4. IT IN UNIVERSITIES MANAGEMENT

### 4.1. Tribhuvan University

There are three universities in Nepal : Tribhuvan University (TU), Sanskrit University (SU) and Kathmandu University (KU). Tribhuvan University is the oldest university in Nepal. Under this university, there are many Institutes such as Institute of Engineering, of Forestry, of Medicine, of Education, of Management, of Humanity and of Science & Technology . These institutes have altogether 209 campuses (i.e. 72 Government and 137 private), where 154,528 student pursue their studies. In most of these institutes microcomputers have been used as a tool for management, but they are used only in central offices. Here, the activities include record keeping, statistical tabulation, research and development, planning, word processing, examination result processing of certificate and Diploma level of Arts and Commerce faculty etc. Apart from this, the mark sheet certificate printing work general mark ledger book printing etc. have also been done. Tribhuvan university is also running a tailor-made application package for the provident fund of TU administrative staff and teachers.

### 4.2. Institute of Engineering

This campus has 2014 students and 350 teachers. At present, the students are studying on the Intermediate of Engineering (IE) and Bachelor of Engineering (BE) level. The campus has the five departments: Civil Department, Architecture Department Mechanical Department, Electrical Department, Electronic Department. Each faculty has microcomputers to support their administrative and teaching staff. To support the management, at present, 15 microcomputers are in use, and 30 for the practical class.

For the central administration of this campus, a 386 model IBM compatible computer is on stand by, which can print lists of scholarship (25%) and (20%) holder students a sample of computer printed list of students getting scholarship and freeship is given in Figure-I. It can also print the evaluation of teachers and students, in terms of marks, employment, subject, department, faculty, seniority, and sex.

For management purposes, this computer can help in selecting a list of students eligible for scholarships for study leave, promotion, demotions and other personal information . It can produce status of provident fund, income tax and staff pay roll. It can be used for Devanagari word processing as well. An example the Devanagari scripts in given in Figure-I.

### 4.3. Institutes Of Medicine

At present, each department of the Teaching Hospital (TH) Institute of Medicine has micro computers to use as a supporting tool for management, in preparing staff pay roll, and income tax output print, Word processing and desktop publishing in English and Devanagari script. Nursing campus of TH has created a complete database of the staff, teachers and students. This database is used for scholarship, promotion, study leave, training, mailing, list and other purposes. Entrance examination processing of 1450 new applicants to the Medical Institute has also started from the 1994 session. Teaching Hospital management is running the following 11 health - related projects. The management of each project is using IT tools. The projects are the following:

a) Corneala Infection Project.
b) South Asian Cataract Management Project
c) Family Health Project
d) Health Learning Project
e) Health Development Project
f) Field Education Project
g) Library Project
h) Research Project
i) Mental Health Project
j) Ear, Nose and Throat Research Project
k) JICA Project

### 4.4. Library

The computer has been used in Tribhuvan University (TU) central library for preparing a bibliographic data base of about 200,000 books, magazines, periodicals, and papers, for book registration, reservation, issue and receipt. To carry out these activities, the library is using CDS/ISIS software package developed by UNESCO. This package was first used by TU central library only in 1993.

### 4.5. Centre for Educational Research & Development

Centre for Educational Research & Development (CERED) is running TU 10+2 TU's project so as to support planning division and to implement a 10+2 system in Nepal. This centre is using the computer for carrying out secondary school space survey, teacher availability, feeder school students survey, teachers work-load survey, teachers personnel record keeping, etc. After completion of these surveys, the results (statistical data) are going to be used for planning and implementation of a 10+2 educational system which is a new system for Nepal. The Ministry of Education, Culture and Social Welfare is waiting for the report of these surveys so as to pinpoint the centres and potential areas for 10+2 classes. Thus, IT plays an important role in planning.

### 4.6. Kathmandu University

Kathmandu University was established in 1992. and presently 1003 students are enrolled in it. Here classes are being run under such faculties as Science & Technology, Management, and the Humanities. Altogether 22 microcomputers have been used in computer science classes. Fourteen computers have been operating to carry out management work of this university. Here also activities include university planning, project control, simulation, record keeping, research and development, account keeping, examination result processing, secretarial services, etc. In this way, information technology has been used to assist top and middle level management of Kathmandu University. This technology has not yet been introduced in Sanskrit University. But at present, having put Devanagari script in ASCII, the Sanskrit University is also considering the introduction of the microcomputer. The characters of the Sanskrit language are based on Devanagari script. An example of Devanagari script used at the Engineering Campus is given Figure-II.

## 5. IT IN MINISTRY OF EDUCATION, CULTURE AND SOCIAL WELFARE

### 5.1. Ministry of Education

The Ministry of Education, Culture and Social Welfare has prepared an educational database on various levels namely on the national, regional, zonal and district level. It has published data such as number of schools by development and geographic region. It has also prepared primary, lower secondary and secondary level enrollment and number of teachers by development and geographic region. Students /school and teacher ratios, higher education enrollment, sector wise distribution of education, budget, etc., are also prepared and published by means of the computer. Other activities at the national level include educational research and development, simulation, planning, tabulation, word processing, etc. Result processing of about 160,000 students who took the school leaving certificate examination in 1993, has been carried out at 208 examination centers covering the whole country. Based on the result, school evaluations at the national, regional, zonal and district level are carried out by the Ministry of Education, Culture and Social Welfare. Apart from this, computers are also used for mark sheet printing, general mark ledger book printing, question paper selection, design and printing pre-SLC examination ledger book printing, etc., which have helped quite a lot in planning and arranging examinations. Certificate printing is underway. Because of the use of computer in the preparation of educational database, the Ministry Education has become more able to control, manage supply and provide the facilities in time. In 1994 the Ministry of Education Culture, and Welfare is carrying out pre and post final examination result processing of 10+2 classes using the computer as a test run. In 51 districts for 18,000 students, they have opened more than 51 examination centres.

### 5.2. Janak Educational Material Centre

Janak Educational Material Center is functioning as a national publishing house on behalf of his Majesty's Government of Nepal. At present, it is printing more than one million books on over a hundred subjects for the primary, lower secondary and secondary schools every year. For this , the center is making use of computers in such activities as computer design, screen design, word processing, editing, etc.

### 5.3. Department of Archaeology

The Department of Archaeology has five powerful microcomputers, which have created a National Archaeological Bibliographic database which has more than one million records Similarly, the department is producing microfilms of historical and old documents. So far, they have produced more than 500,000 of these. In this project the German government is helping the department.

The National Library of Nepal has more than 100,000 books, magazines and periodicals. Using a the CDS/ISIS package, they are producing an-up-to-data bibliographic database. This library is run by the Ministry of Education, Department of Archaeology. More than 40 other libraries are also using the CDS/ISIS package which has made it very convenient to handle and manage library work in tracing and classifying books on different subjects. In Madan Library, located in Patan, Devanagari script has been used for creating a database and for word processing. This is an important step in the development of computer usage in IBM pc.

## 6. IMPACT OF IT ON EDUCATION MANAGEMENT

### 6.1. Education management

Like other sectors, educational management is also affected by Information Technology (IT). The teachers, educational administrators and experts, who are using IT tools at present, have become more capable, more reliable and more logical. Their working style has changed. So at present, the impact of IT in Nepal has been positive. This has motivated some private schools, campuses and private organizations and they have accordingly started using micro computers to back up their management according to their capacity and needs.

### 6.2. Problems

There are some problems that need to be tackled urgently. Firstly, there is a lack of knowledge on the part of senior officials regarding IT use in management. Secondly, there is a considerable lack of well-trained manpower. Apart from this, there is felt to be a large budget constraint for buying necessary hardware and software. Last but not least is a lack of development of computer- friendly culture and environment.

## 7. CONCLUSION

The use of Information Technology in the management of daily, monthly and annual activities of schools, campuses, universities and the Ministry of Educational is gradually increasing, albeit on a limited scale. If this technology, which is expected to expedite all-round development of the country, could be used for education management, it would add momentum to education development. Development of education will bring major and prompt changes in the mental, economic, social and scientific spheres. It is also expected to augment the all-round development of nations and the of world as a whole. Nepal has a strong belief in the tremendous role played by Information Technology in the enhancement of development.

## REFERENCE

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## 2. Figure-I

*Computer printed list of students getting Stipend and freeship.*

### DETAILS OF SCHOLARSHIP
### DIPLOMA IN ARCHITECTURE ENGINEERING
### 2ND YEAR 1ST PART
### (COMMENCED ON 5TH JESTHA, 2049)

| S.NO. | BATCH | CRN | NAME OF STUDENTS | SCORE | FSUB | STATUS | REMARKS |
|---|---|---|---|---|---|---|---|
| 1. | 2047 | 324 | HARI DANGOL | 503 | | STIP | |
| 2. | 2047 | 314 | BINDU SHRESTHA | 494 | | STIP | |
| 3. | 2047 | 365 | SURESH KR-RAUT | 473 | | STIP | |
| 4. | 2047 | 340 | PUSPA SHANKER SHRESTHA | 472 | | STIP | |
| 5. | 2047 | 325 | YADAV PD. MAINALI | 467 | | STIP | |
| 6. | 2047 | 321 | HOM NATH POUDYAL | 467 | | STIP | |
| 7. | 2047 | 334 | MAMATA POUDYAL | 429 | | FREE | |
| 8. | 2047 | 306 | RUPAL SHRESTHA | 440 | | FREE | |

## 3. Figure-II

*A sample of a notice, for the students of the Campus in Devanagari script.*

इन्जिनियरिंग अध्ययन सस्थान
पुल्चोक क्याम्पस
सूचना
२०५१/३/२५ मा

आगामी वर्ष २०५१ श्रावण १ गते देखि यस क्याम्पसमा अध्ययन गरी रहेका सिभील डिपार्टमेन्ट, आर्किटक्चर डिपार्टमेन्ट, मेकानिकल डिपार्टमेन्ट, इलेक्ट्रीकल डिपार्टमेन्ट र इलेक्ट्रोनीक डिपार्टमेन्टका सम्पूर्ण विद्यार्थिहरुलाई उनीहरुको ३ वर्ष पदाई भित्र कुनै एक सेमेष्टरमा कम्प्युटर कोर्ष लिनुपर्ने गरीएको ब्यहोरा यो सूचना द्वारा जानकारी गराइन्छ ।

**क्याम्पस प्रमूख**

# 13

# Information technology and the management of Victorian schools - providing flexibility or enabling better central control?

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**Abstract**:

Considerable use is now made of information technology in the management of Victorian Schools due partly to the early efforts of individual teachers, but more to Education Ministry central initiatives. This paper traces the use of computers in school management and the issues raised. One such issue is the feeling amongst a number of educators that IT is being used to force schools to adopt centrally determined administrative procedures, rather than to provide flexible structures to assist them to manage themselves. Planned future directions for school education, especially the 'Schools of the Future' project, make the increased use of IT essential in managing schools. What computer-based management systems are currently available, and how schools make use of these systems is demonstrated in case studies. A major problem identified is the lack of adequate available in-service training.

Keyword Codes: K.3.1; K.4.3; H.4.0
Keywords: Computer Uses in Education; Organisational Impacts; Information Systems applications.

## 1. INTRODUCTION

In the early 1980s a major study of the possible uses of computers in Australian schools by the Commonwealth Schools Commission identified important administrative applications including school accounts, stock records and student records. It saw these, however, as distinct from the curriculum use of computers in that "access to them is generally restricted to the school executive and administrative staff". [1]

In Victorian schools there has always been tension between those educators whose main interest is to use computers in the classroom, and those who are more concerned in using them to assist with management functions. Whilst both functions have always been recognised as important, over the years each group has seen what they were doing as the *more* important, and been a little suspicious of the other. The Schools Commission report followed by the setting up of *separate* Computer Education and Administrative Computing units by the Victorian Ministry of Education in the mid-1980s did nothing to reduce this problem.

### 1.1 Structure of the Victorian School System

Government schools in Victoria enrol only about 65% of Victorian students, the remainder being catered for by the independent schools. Until the mid-1980s the Victorian

State School System consisted of three separate divisions: Primary Schools (P-6), Secondary Schools (7-12) and Technical Schools (7-11). These divisions operated almost as separate school systems, while independent schools had little contact with state schools.

### 1.2 Early use of computers in the management of Victorian schools

In order to understand why current systems are as they are, it is instructive to examine how the use of computer-based management systems evolved and the political environment in which this has occurred. In the early 1970s the first computers began to appear in Victorian schools. These early machines, often loaned or leased PDP-8s and the like, usually entered the school's mathematics department and were used solely for programming thus having little overall impact on the educational program or management of these schools. In this period however, a number of the larger non-government schools purchased their own minicomputers to use in administrative applications such as payroll, accounts and student enrolments [2]. Later the use of these minicomputers was extended to such management applications as student/class allocation, timetabling and student reports, a pattern that is still followed today.

In Government schools much less administrative work needed to be done 'on-site' as the Education Department's central bureaucracy handled the management of such things as teachers' salaries, building contracts and school cleaning. In the mid to late-1970s a number of State secondary schools began making use of minicomputers located in nearby universities for tasks including student/class allocation and the marking of tests. When microcomputers appeared in the late 1970s and early 1980s, a number of management applications, typically written by teachers themselves, also began to emerge. These included computer programs to manage the results of school sports meetings, simple financial packages, student records databases and programs to assist in timetabling [3]. The availability of microcomputers also provided a stimulus for the adoption of computerised school library systems.

### 1.3 Victorian Education Ministry administrative computing initiatives in the 1980s

In the early 1980s a newly elected Victorian Government discovered that it was impossible to get consistent financial data from its governments departments, as each had its own accounting system [4]. This meant that the government was unable to draw up a balance sheet for the State of Victoria as a whole, and as a consequence it quickly decided to set up accounting standards that would be used by all government departments, and to institute a centralised accounting system.

Furthermore, the Auditor General had been particularly critical of the Ministry of Education as only about 40% of its schools had been sending in detailed statements of expenditure. The task of sending field auditors to all of these schools would have been enormous, so the solution decided upon was to supply each school with an administrative computer system and specific accounting software in order to make them more accountable [4]. The Ministry of Education considered itself big enough not to need to outsource this task and, in 1985, set up the Schools Administrative Computing Unit (SACU) with the initial task of developing suitable accounting software.

John Birse, who was soon to become the co-ordinator of this unit, describes how its first job was to determine what language the software package should be written in. They chose Dataflex in the belief that this would simplify future program maintenance [4]. At a curriculum level at that time, most primary and secondary schools used Apple hardware and this presented problems in the development of administrative systems which would need to be similar to those used in business and hence be based on a CP/M or MS-DOS platform. The technical schools of the day used mainly CP/M equipment but this was right at the time that CP/M was about to be replaced in most business applications by MS-DOS.

A double entry accounting system was then developed in Dataflex and trialed at a number of schools. In line with the aim of making schools more centrally accountable, this system *imposed* an unalterable chart of accounts, which while suitable for large secondary and technical schools was seen by small primary schools as unnecessarily complex. Birse suggests that "the system was definitely not set up to empower schools. It was fairly imposed, and from that point of view they got it wrong." [4]

To get things going, participating schools were each given an administrative computer (initially an IBM-AT) and the new accounting software. Installation and training were to be provided by SACU but, according to Birse, initially SACU just "dropped boxes on schools" and what training there was came later. SACU had only six consultants, three of whom were auditors and three with a school background, nowhere near enough to perform the enormous task required of them. The training of school administrative staff suffered accordingly, a problem that continues today.

## 2. ADMINISTRATIVE COMPUTING SYSTEMS IN SCHOOLS

Following the development of the Schools Accounting System (SAS), as it came to be known, SACU went on to develop a Student Records package as a step towards the currently available systems. There are now four different computer-based management systems in place in Victorian Government schools. These are known as SAS, CAAS, VASS and CASES.

### 2.1 Schools Accounting System (SAS)

This double entry accounting system is now installed in over 1400 schools. Extensions to the system allow it to accept input directly from a cash register, so facilitating the collection of money from students.

### 2.2 Computer Aided Administrative System (CAAS)

This is essentially a DBMS, complete with a set of pre-designed reports. It is currently installed in 1400 schools and is set up to hold student records and staff details.

### 2.3 Victorian Certificate of Education Administrative Software System (VASS)

In 1992, after several years of discussion and planning, a new year 11/12 course; the Victorian Certificate of Education (VCE) was introduced into Victorian schools. VCE students study 24 semester length units over their final two years at school, allowin much more choice than the previous Higher School Certificate (HSC). Assessment is als handled quite differently. Under the old HSC, assessment in most subjects consisted of an external examination, typically worth 50% of the marks, with school-assessed option material making up the remainder. The VCE, on the other hand, involves no external examinations, but a number of Common Assessment Tasks (CATs). Some of these CATs are externally set and marked while others are school assessed with some external moderation. This large component of school-based assessment requires schools to keep much more strict and comprehensive student records than before.

To facilitate this record keeping, and the transfer of data to the Board of Studies (BOS), the Ministry of Education then provided each secondary school with a microcomputer, laser printer, modem and special VASS software. It also initiated a significant programme of in-service training for teachers acting as school VCE co-ordinators, to assist them to use the system. The VASS system is installed in 640 school locations, and is intended to provide both a school database of VCE details and result, and a mechanism for the transfer of data between the BOS and the schools. Data from the Board is typically sent via modem while school results are returned on floppy disk. The VASS system provides the following functions:

1. Student menu - Student personal and Home Group details.
2. Teacher menu - Details of VCE teachers.
3. VCE programs setup menu - VCE units offered, teachers allocated, CAT dates, projected enrolments.
4. Student programs menu - Students allocated to classes, student status enquiry and program summary, print class lists, print student CAT timetables.
5. Results menu - Results input sheets, co-ordinator's record sheets, student CAT results, VCE student profiles, results enquiry, Home Group summary sheets, interim reports, end-of-unit reports, students-at-risk reports, create remote results disk.
6. Data transfer menu - School to BOS data transfer: VCE projected enrolments, actual enrolments, initial assessments, unit completion, student profiles, school information. BOS to school data transfer: confirmation of enrolments, timelines. School to School data transfer: details of transferring students.
7. End of year procedures menu - Transfer of VASS data to CAAS, import teacher and student details from CAAS, student history, delete past student data, BOS unit descriptions, statistics on student enrolment, unit completion, CATs, results.
8. System maintenance menu - Backup, VASS defaults, upgrade, authorised users, passwords, query database, mail merge - mailing labels, student letters.
9. Student enquiries menu - Student summary or full details, student details by Form group, Home Group lists, population details.

## 2.4 Computerised Administrative Systems Environment in Schools (CASES)

The previously described systems are all function specific, and the Directorate of School Education (DSE) is now in the process of introducing a more integrated system that will eventually link the following components:

- School Finance (SAS)
- Student and Staff Administration (CAAS)
- Assets Management
- VCE Administration (VASS)

The DSE describes the CASES development philosophy as placing "great emphasis on an integrated database management system. All school records should be part of an overall construct where a general information system comprising students, staff, assets, facilities and financial data is readily available to school-based personnel to assist in the administrative process."[5] Some of this linking is present in current versions of CASES while more is to be added later. CASES development is undertaken by the CASES Development Section (SACU's successor) in Dataflex 2.3. CASES is designed to operate in a Novell Netware LAN environment, and to be able to transfer data to Windows applications such as Microsoft Word. Telecom's Keylink facility, along with the Desklink package, is to be used for electronic data transfer between schools and the DSE.

CASES will provide the following sub-systems, not all of which are implemented in the current release:

1. Student administration.
2. Course selection and timetabling.
3. Academic administration.
4. Unit goals and student assessment.
5. Travel/transport and locations.
6. Personnel administration.
7. Census reporting & end of semester/year.
8. Assets register.
9. System utilities and computer setup.

### 2.5 Decision Support Capabilities

Schools will, of course, be able to use some of the reports generated by SAS, CAAS, VASS or CASES to assist with management decision making, but none of these systems has been equipped with the models necessary to provide schools with proper educational decision support facilities.

## 3. THE 'SCHOOLS OF THE FUTURE' PROJECT

The Victorian Government is piloting a programme in which a number of selected schools will become, to a large degree, self managing. The schools involved in this pilot project are to be known as 'Schools of the Future'. The intention is to devolve much of the administration, formerly done centrally, to these self managing schools, which will mean that as well as student administration, assets management and finances, additional personnel tasks such as teacher absences and leave, as well as some payroll and other functions will devolve to the school level. The DSE suggests that successful implementation of the pilot scheme requires the provision of appropriate information technology facilities and support at the school level. The pilot schools, depending on their size, are thus now being provided with several networked PCs, a CD-ROM drive, a modem, a laser printer and CASES software. The schools will be asked do much of their reporting to the DSE from CASES via modem, and use of this software will soon become essential.

An article in the DSE's Education News explains that "CASES is central to enabling Schools of the Future to perform functions associated with self management and for the operation of efficient school-based administrative systems." [6] It adds that CASES will be used "to link schools to an electronic Wide Area Network (WAN) whereby schools will be able to link to the corporate system to maintain and retrieve basic personnel data, payroll entitlements and disbursement data." [6] This link was still to be implemented in May 1994.

In a departure from past practice the computer equipment supplied to the Schools of the Future will be leased by the Victorian Government from a commercial supplier. After a period of three years it will be updated. In addition to the CASES software, schools will be provided with Windows for Workgroups, Microsoft Word and Microsoft Works. DSE licensing agreements mean that these schools will also be able to purchase other Microsoft software at substantially reduced prices.

It is planned to provide information on school policies, procedures and guidelines, as well as the CASES manuals themselves, in CD-ROM format. A package to be known as Information Utility for Schools (InformUS), and using special Australian developed ISYS text retrieval software, is currently being developed. In 1995 the Government intended to extend the Schools of the Future program to cover all state schools.

## 4. HOW THE PACKAGES ARE BEING USED: A TALE OF TWO SCHOOLS

### 4.1 Viewbank College

Viewbank College is a Melbourne secondary school recently formed by the merger of Rosanna East and Banyule High Schools. The new school has 793 students, 59 teaching staff and 5 ancillary staff, but is not a School of the Future. Both of the constituent schools had been using computers in curriculum and management applications for some time, but to different degrees and with different hardware.

Lois Maguire, the school bursar, has been involved in the use of computers in school management for some years, and notes that substantial efficiency improvements have resulted from the introduction of these systems. Viewbank uses the Schools Accounting System (SAS) in stand-alone mode for accounts receivable, accounts payable and to produce trial balances. The system is presently unable to depreciate or hold assets. The school intends soon to purchase a new cash register which will be linked directly into the system. It is envisaged that this will save considerable time when accepting money for excursions and bookshop sales. [7]

Viewbank also uses the Computer Aided Administration System (CAAS) to store data on school assets, student personal information, student subject information and student absences. The system is also capable of handling staff absences but this facility is not used by the school at present. Maguire notes that it is very time consuming to enter student data, taking up to four minutes per student. Part of the problem is that the pre-designed input forms contain many fields not required by the school, but which cannot be deleted. This system is also used in stand alone mode but the school is currently in the process of installing a network which will provide read-only access to this information to the Principal, Vice Principal and various Year Level Co-ordinators around the school. Although the student records system is considered to be quite useful, the school's general office also maintains a manually operated card system of student records, as retrieval of data from the computer-based system is thought to take too long. CAAS is not linked to the accounting system.

The school library uses a Dynix Library System for cataloguing and borrowing functions, but like CAAS this is not linked with other management systems. Similarly, the commercial package used to assist in the production of the school timetable is also function specific.

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In offering VCE studies, Viewbank College is obliged to make use of the VASS system [8] which is also function specific at present, accept that it is possible to import a list of students from the Student Records System. The VASS database comes, each year, from the Board of Studies with the table of subjects already entered so the school has only to enter appropriate codes for the subjects studied by each student, and to indicate which teachers will take each class. The prime purpose of this system is to facilitate the transfer of student results from the school to the Board of Studies, and so a floppy disk is *posted* to the Board every time student data changes. The school also has a modem link to the Board but at present this is used only to receive messages from the Board. Unfortunately however no paper is saved as the school has to make hard copies of all its electronic mail anyway! Originally it was thought that each subject teacher would enter their own student results into the VASS computer, but this was found to be impracticable and staff now give hand written lists of results to the VASS co-ordinator who enters them all in batch mode. Maguire believes that the VASS system is running quite smoothly now.

Maguire sees distinct advantages in the computerised systems, noting that in particular the annual school census is now easier to perform, assets are more controllable and expenses like insurance and cleaning costs easier to calculate. At present no data is sent via modem to the DSE but it is likely that soon such things as census data, school statistics and details of teacher absences will be sent direct.

### 4.2 Eltham East Primary School

Eltham East Primary School is a vibrant community of 650 students led by an energetic, newly appointed Principal. The school has 34.5 teachers and 1.5 administrative staff, and has recently been selected to participate in the 'Schools of the Future' programme. The school prides itself in fostering good community relations and on providing students and staff with a pleasant work environment. It is a progressive school and the School Charter states that "Each classroom has its own computer and particular attention is being paid to developing the use of this technology in classroom programs" [9].

Bill Schrank, Eltham East's Principal, confesses that he has only recently attained any degree of computer literacy but that now, in addition to the PC in his office, he also has a computer at home. As a School of the Future, Eltham East has recently received a file server, four network workstations, a laser printer and a modem from the DSE. When the equipment was delivered he and the office staff were given a 30 minute tutorial by the supplier. This is the only training any of them have yet received and there has been no instruction at all on the use of the network! The file server, laser printer and two of the 486SX computers have been located in the general office, with the others computers in the offices of the Principal and Vice Principal. The school is not currently using the modem but has purchased, from its own funds, a cash register which is linked to the accounting system. One of the office computers is used to run the Student Records package and Schools Accounting System, while the other is used for word processing.

The Principal uses the PC in his office to compose and type his own letters using Word for Windows. [10] His computer is linked to the other management systems but he does not make use of these yet. Schrank thought about the wisdom of spending time word processing his own letters, rather than having them typed by the secretary, but decided that doing so would not only be quicker, but would also give him much needed practice at using his computer. Only recently did he discover than in saving his work to his own hard disk no one else was able to access it across the network - this was not pointed out in the 30 minute introduction. Schrank told me that one of his office staff is booked in to attend a full day DSE professional development activity on the use of the administrative systems. He would have liked to send more staff but was unable because of limited available places and high demand. He is most critical of the DSE's provision of training in the use of the system. [10]

The fourth workstation in the Vice Principal's office will later also be used to access the Student Records system but is now used mainly for writing daily staff notices using Word for Windows. The school has a very full timetable and would like to make use of timetabling software, but has so far not been able to find anything suitable. The school library has an OASIS system, using pre-printed bar codes, for cataloguing and borrowing. Two library terminals provide student access to the catalogue (plus another in the library work room) and one terminal is used for loans. This system is not linked to the administrative system. In the staffroom there is a stand alone Apple Macintosh Plus with a laser printer for staff use in the preparation of teaching materials and student reports. An MS-DOS computer linked to the library system has also just been installed in the staffroom. But of course, a modern school does not use only computer technology, and Eltham East Primary also has two mobile phones, a fax machine, three photocopiers and a copy printer for staff and administrative use.

Bill Schrank sees many advantages in the use of the computer-based management systems - particularly when the school is shown how to use them properly. He has already made use of a report on parent occupations, provided by the Student Records System, to locate a parent to assist with concreting and another for a landscape gardening project. The computer-based assets list means that finding how many chairs a given classroom should have is now 'childs play'. He is looking forward to being able to produce the statistics for the mid-year census using the computer system. This previously was a most onerous task. The on-line system, using the modem, is still to come, but soon this will be used for reporting staff illness and transmitting school statistics and census data to the DSE.

## 5. IN-SERVICE EDUCATION OF SCHOOL PRINCIPALS AND OFFICE STAFF

The importance of convincing school Principals of the advantages of using computers in school management should not be taken for granted. In the past Principals were usually former teachers who had little experience or knowledge of management. With new appointment procedures however, aspiring Principals need to acquire management skills and they often do so by enrolling in appropriate tertiary courses at the Graduate Certificate, Graduate Diploma or Masters level. For example Victoria University of Technology offers award and short courses in information resource management and the use of common microcomputer software packages to educational administrators.

It is clear, however, that the problem of training management, administrative and clerical staff in the specific use of CASES software has been underestimated by the Directorate of School Education. While training in the earlier introduced VASS system was quite comprehensive, this has not been true of CASES. Courses are offered in only a few of the DSE School Support Centres and there are insufficient available places in those courses which are offered to meet the immediate demand. The amount of system documentation supplied with the software is also quite daunting to educational administrators, with over 400 pages on VASS, 300 pages on SAS and 500 pages on CASES. Schools say that the quality of the documentation is not the problem, just its quantity. Without guidance, they find it hard to distinguish the forest from the trees or even to know where to begin.

Meanwhile, schools are left to muddle along as best they can. According to Bill Schrank, what they really need is a consultant to come to the school to assist them on-site. Such assistance is however not available and the only alternative is to phone the CASES hotline which apparently receives up to 2000 calls per day.

## 6. ISSUES OF CENTRAL CONTROL

From the time of the first SACU accounting package, some schools have questioned whether these systems were intended to assist or to control them. Whereas previously they were able to keep their own financial and student records in their own way, now they would have to use a common system provided by the Education Ministry. In a large centralised system such as this, keeping track of what schools are *really* doing is difficult and relies to a great extent on the willing co-operation of each school. While it would be very hard for any to argue against the improved efficiency the use of information technology has brought, there has nevertheless been an increasing feeling that 'Big Brother' was looking every more intently at what they are doing. The Education Ministry has done nothing to reduce this fear.

John Birse [4] describes development of these systems as being based on a "purely top-down philosophy" designed primarily to suit the Ministry. He is glad that early dreams of terminals in schools which would be linked to the central system have not been fulfilled, but notes that this could still happen in the future. Lois Maguire [7] says that little support was ever given to school bursars who were placed under pressure to learn the new systems or resign. She complains that "If you feel 'they' don't care you won't try new things." In 1989 an Education Ministry review [11] of administrative staff in Victorian schools recommended that in view of the implementation of new technology, increased training and access to consultancy services be made available to these people. Little seems to have been done, and the criticism that like any system which does not cater to the needs and anxieties of the people involved, this system will not reach its full potential, seems an accurate one.

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# 14

## State of the Art in Information Technology in Educational Management in the Czech Republic

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### Abstract

Some basic information concerning education in the Czech Republic from the point of view of information and management system is given. The problems of the interface between local schools information systems and the central system as a part of the State Information System are discussed. The role of the Czech Educational and Scientific Network (CESNET) in educational management is described.

Keyword Codes: K.3.0; K.3.1; C.2.0
Keywords: Computers and Education, General; Computer Uses in Education; Computer Communication Networks, General

## 1. INTRODUCTION

Even though the Czech Republic only in arose the break-down of Czechoslovakia after January 1993, the Czech State, its culture and its educational system have a long history.

The first schools in our country, in the 9th and 10th centuries, were church schools attached to monasteries. Records of secular schools date back to the 13th century. In the 14th century, under the reign of the Czech King and Roman Emperor Charles IV, Prague was a European cultural center. In 1348 Charles IV founded Charles University, the oldest European university north of the Alps. Jan Amos Comenius, the great Czech philosopher, theologian and educationalist of the seventeenth century, is also known as a teacher of nations.

Education has always played a serious role in the history of our nation. Neither the Nazis, nor the communists were able to devastate our educational system, even though they damaged it considerably. Of course, there is much to be reformed, but from the international point of view education in the Czech Republic is on a fairly good level [1]. In the age category from 15 to 64, about 8 % of the population has university education, 63 % upper secondary education, and 28 % lower secondary education; only 1 % has not finished secondary education. The rather low percentage of people with higher education can be explained by the fact that our country has so far not had any post-secondary education except for universities. Schools corresponding for example to the German Fachhochschule have been experimental only.

Voluntary kindergartens are attended by children from 3 to 5 years. Compulsory education is up to 16 years, starting at 6. The first eight years usually consist of basic (elementary) school which has two grades, with continuation either in the so called gymnasium (high school), which prepares students directly for further university studies, or in a specialised upper secondary school, or in a secondary vocational school, which can take 2, 3 or 4 years. Gymnasiums, specialised upper secondary schools and four-year secondary vocational schools are fully comparable with colleges in the USA and they are completed with the so-called Maturity certificate after which students can continue their studies at a university. About 50% of secondary students obtain this certificate.

This sector of the educational system is administered regionally by means of 85 local school authorities for single districts. Districts have usually about 50 to 300 thousand inhabitants. Greater schools have full legal independence and the district authority allocates them money from the state budget only. Smaller schools are directly managed by the school authorities.

Since 1990, a number of private, church or municipal schools have one's rise. These schools can collect school-fees or special allowances. The state, however, equally contributes to pupils of all types of schools, including private ones. School-fees serve only for improvement of education above the current standard.

The educational system is very liberal regarding the curriculum and the pedagogical methods used. But there are exceptions; for example, eight-year gymnasiums for gifted children starting from age ten.

In the Czech Republic there are 23 universities (from Charles University which is the largest with approximately 20,000 students, to small art universities). The universities comprise 104 faculties. Faculties are relatively independent of the university management. More than 109,000 students are at our universities at present. The typical minimal period of studies is: three years for the bachelor's degree, five years for the master's degree, and eight years for the doctoral degree. Universities are quite independent, their management is elected by the academic community and the state does not interfere in their activities, with the exception of the accreditation for awarding academic degrees and of the allocation of funds from the state budget which is generally done according to number of students.

## 2. EDUCATIONAL MANAGEMENT

At present a broad liberalisation of the educational system is in progress, regarding both the curriculum and interior organisation and management of schools. The state supports the principle that everything is to be decided at the lowest possible competent level.

On the other hand, as all schools, including the church and the private ones, are predominantly financed from the state budget it is necessary at a time of economic transformation, to manage the means very carefully, but equitably.

This situation puts heavy demands on the educational information system. On the central level, it is necessary to collect and evaluate performance data of all schools and educational facilities for state statistics and for ministerial decisions. This involves not only numbers of teachers, students and pupils, but also all other factors influencing the budget, the financial demands of the subject of study, and for example the specific geographical conditions of a school, numbers of handicapped children integrated, etc.

Regarding the independence of schools, each school has a right to buy a hardware and software for its purpose separately. Therefore the hardware and software of various institutions is very diversified. Some products for internal management may be centrally recommended and supported but they are not compulsory.

On the levels primary and secondary the schools and local school authorities use various program tools ranging from common word processors, spreadsheets, special programs for evaluating the pupils' results including certificate printing, up to relatively sophisticated programs for timetabling. It is of interest that although this latter task is an NP-complete problem and, therefore cannot be solved in a practical way for a non-trivial volume of data, we have reached some success in assembling heuristic and user friendly systems, which work on the principle of man-machine co-operation, combining intuitive human decision with the complete monitoring and possible collision control contributed by the computer. The central level support the program system of staff and wages linked to the finance management of the school and the compulsory deliveries to social and health insurance funds. This system is very adequate, and its maintenance provides the possibility of immediate reaction to frequent changes in the laws.

At universities faculties usually create their own information systems. They are as a rule complex systems, often developed by CASE-tools. Owing to the considerable differences in organisation of the individual faculties the created information systems mutually differ substantially. Some of such systems are not finished yet. In general, problems arise from insufficient co-operation between the information systems of the individual faculties and in adequate interface with the central information system for decisions on government level.

The Central Data Base for the educational system is managed by the Institute for Informatics in Education (IIE) which is also the only reporting place in the education branch towards state statistics. The Institute also insures the methodology of the data flow, defines the interface for the data transfer among subjects, and maintains the Educational Data Base.

At present the Educational Data Base in the IIE comprises 21 sub-bases of performances of schools and their employees, and their wage means in the total range of about 500 MByte, including 48 educational and state code-books. The data base is operated and maintained by a team of about 25 employees within the local LANTASTIC network of computers of very different performance types, compatible with the IBM PC standard.

The base stores updated data on more than 25,000 subjects (schools and educational facilities) and 104 university faculties and 45 other educational organisations. In the case of regional educational system the data are collecting through the mediation of 85 local educational authorities. As the level of technology used by reporting institutions as well as the qualifications of persons working with data are since very different, the greatest problem is the observance of the defined interface of transferred data and their validity and consistency. The IIE tries to improve this by developing and supplying software that make it possible to perform as many controls as possible directly at the reporting place before sending data to the center. The situation is not yet fully satisfactory because not all institutions use these tools.

Because the data in the central information system are a single source for finance allocation from the state budget to schools, no incomplete inquiry is sufficient.

The actual communication with the regional educational system is carried out by means of floppy disks (roughly 90 %) and paper forms (10 %). Communication by means of INTERNET network is just starting. In higher education, most of the data are transferred through the INTERNET network which is described in the following section.

To conclude of this section, we will briefly mention other roles of the IIE.

Besides the collection of statistics and management educational information, the other roles of the IIE are:

- to get and to publish information concerning educational organisation and management in other countries and pedagogical methods applied there
- to support the utilisation of information technologies at all levels of education and to help teachers with the choice of hardware and software, and with the creation of educational software or multimedia teaching applications.

IIE also includes the State Pedagogical Comenius Library, the public library which with its fund of approximately half a million books is the Central State Scientific Library for pedagogy and education, the Collection Fund of text books including old prints of high historic value, and the Methodical Centre for the network of libraries in the Czech educational system. This library also includes the Czech National Centre for the European Database of the Pedagogical Research EUDISED. Using the pedagogical thesaurus and computer technology, the records of a pedagogical research in the Czech Republic are procesed there, to suply the EUDISED database. On the other hand, from the EUDISED database information is acquired for our specialists.

## 3. CESNET (Czech Educational and Scientific NETwork)

At the moment, users in the Czech Republic can directly access the following Wide Area Computer Networks:

- EARN, the European Academic and Research Network with ten nodes plays an important role in our Wide Area Networking. On CSEARN (the Czech and Slovak EARN node) at the Czech Technical University Computing Centre in Prague the NETSERV, LITSERV and other standard EARN/BITNET services are supported as well as an EARN INTERNET E-mail gateway.
- EUnet, a network of Unix-based computers, has 19 nodes and is used mostly at commercial institutions. Dial-up links are used, E-mail and electronic conferences are supported.
- FIDONET, a network of MS-DOS based personal computers, which however lies outside the scope of this article.
- INTERNET, the world-wide "network of networks" which uses TCP/IP communication protocols and provides some services not available in other networks (remote login, etc.) is the most attractive for our users.

At the end of 1991, the Czech government institutions in the educational sphere proposed the creation of a common infrastructure for the whole academic and research community in the former Czechoslovakia. The Federal project FESNET was accepted in the spring of the year 1992. After Czechoslovakia was divide into the Czech Republic and the Slovak Republic, FESNET was divided into two independent parts: CESNET and SANET (Slovak Academic Network). The CESNET backbone has been operated since February 1993.

The INTERNET TCP/IP protocols are also acceptable for many EARN and EUnet computers and so they have been selected as the basic protocols of the academic network. The CESNET backbone can carry additional communication protocols (AppleTalk, DECnet, IPX, X.25, etc.) because multiprotocol routers are used at the CESNET backbone and at all CESNET nodes (CISCO routers have been selected).

The CESNET project tried to select the communication media with the best price/performance ratio. Various technologies (satellite, microwave, terrestrial links) have been considered by tenders from several suppliers. Main links allow 64 kb/s, several minor locations are interconnected by digital or analog 19.2 kb/s links.

The CESNET backbone connects all main 15 Czech and Moravian university cities.

A part of the CESNET backbone is a metropolitan Prague Academic Network, PAS, which contains 20 CISCO routers in various Prague universities, main libraries, in the Czech Academy of Science, the Ministry of Education, Youth and Physical Training and also in the Institute for Informatics in Education. The situation is similar in the Moravian capital Brno.

The administration of each campus-wide or academic metropolitan network (with hundreds or thousands of hosts) connected to the CESNET will be responsible for monitoring and managing their own traffic. Network management programmes using the SNMP protocol (PSI SNMP version 4.1) running mostly in the SUN workstations are used.

The CESNET is already using the following international links:

- Prague - Vienna (EBONE, Austria, 128 kb/s)
- Prague - Bonn (DFN, Germany, 64 kb/s)
- Prague - Amsterdam (Europanet EMPB, the Netherlands, 64 kb/s)
- Liberec - Zittau (DFN, Germany, 64 kb/s)
- Prague - Banská Bystrica (SANET, Slovakia, 64 kb/s).

In addition to the usual services (E-mail, Telnet, FTP, etc.) for users of the CESNET there are available:

- Interconnected academic libraries
- Academic databases on publication activities
- Centralised distribution of Usenet news.

Details for the CESNET, may be finded in the text from Mr. J. Gruntorád, the CESNET project manager, on the e-mail address gopher.feld.cvut.cz (147.32.192.5).

Building the basic computer infrastructure in the Czech Republic was a very significant step in making the latest information technologies available to the academic community and developing reliable interactive information services.

This infrastructure is of course used for the purpose of the State Information system in the educational sphere. All statistical and economic data from 104 university faculties are collected, with few exceptions (less than 10 %), by means of the CESNET network. Some of the 85 local school authorities also use CESNET directly; alternatively they can use the dial-up connection in their nearest CESNET node. The network is also accessible from EUROTEL.25 Public Data Network. But for the data transfer to local educational authorities for the primary and secondary education level, a floppy disks as a transfer media are still in common use, because of problems with the national telephone network reliability.

## 4. CONCLUSION

New educational laws are in the stage of evolution and new arrangement of regions and districts is being prepared. New laws obviously will interfere with educational management. Therefore the educational information and management system should be as flexible as possible and we shall have to wait before we can make certain decisions.

We must conclude that organisational problems in dealing with the collection and verification of data from schools and local authorities for the educational component of the State Information System are still very serious, comparable to hardware and software networking problems accompanying the data transfer. The CESNET offres realistic improvement in educational management in our country. But the fundamental issue is to clarify information needs, data flows, and necessary time periodicity for all data that are useful for the educational information and management system, and to define data standards and interfaces.

One idea which may help to keep the consistency of central government needs and the maximal possible independence of schools may be to use networking not only for sending messages and data, and for sharing programs, but also for distributed processing. More complicated objects such as whole transactions can be mailed using the network. One software package based on this idea is presently being developed.

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## PART THREE

# Higher Education

# 15

## Interactive Voice Response – More Power to the Students

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### Abstract

Interactive Voice Response Technology allows access to institutional computer systems by way of a telephone. This means that students can be given access to their own information at any time from virtually anywhere they have access to a telephone. They can find out what it is and change it if they want. Because the host computer system still applies course rules, the changes made by students can still fall within the requirements of the institution.

Keyword codes: H.5.2; I.2.1; C.2.4
Keywords: User Interfaces; Applications and Expert Systems; Distributed Systems

### 1. WHAT IS VOICE RESPONSE?

Voice Response should not be confused with Voice Recognition. Voice Response is concerned with information that is produced by a computer and presented to a caller - Voice Recognition is concerned with information going the other way.

The voice presented to the caller by the Voice Responses System (VRS) can be in one of two forms - synthesised or digitised. Synthesised voice is machine produced and is reminiscent of 'talking robots'. Although text-to-voice processing (having a computer translate a word of text into sounds) is improving all the time, the resultant voice still sounds artificial, and algorithms to cope with unusual pronunciations or different pronunciations of the same word still have a fair way to go. Digitised voice, on the other hand, is voice that has been recorded by someone. Consequently, it sounds like a person talking on the other end of the telephone. The quality and presentability are much higher than synthesised voice. It does, however, mean that every word to be spoken must be recorded.

A Voice Processing System (VPS) goes one step further - it allows you to record parts of messages and it combines the appropriate parts into a complete message and speaks it to the caller. For example, you might record the following messages:

*Your enrolment for semester*
*is as follows*
*the digits 1 to 9*

Depending on the value of the semester required, the VPS can put the appropriate parts together and produce a single message such as "*Your enrolment for semester two is as follows*" and present it to the caller. This is a very powerful feature of Voice Processing Systems.

## 2. WHAT IS INTERACTIVE VOICE RESPONSE?

Interactive Voice Response (IVR) Systems allow two-way interaction - the caller can give the system information as well as receive it. This information can be used to navigate around the options available on the VPS or as input into a remote database. Students, for example, can enter information that writes to or reads from a remote host database. The VPS may ask for a student number. When the caller enters it, the VPS sends it to the host computer for validation. The student's enrolment information might then be sent back to the VPS to be spoken to the student.

## 3. HOW IS INFORMATION ENTERED AT THE TELEPHONE?

There are three ways to enter information at the telephone:

**Voice Input**.This is Voice Recognition. The caller speaks into the telephone handset and the VPS interprets what is said and translates it into data that can be sent to a computer. At the moment, Voice Recognition is in its infancy. The digits 0 to 9, yes and no are about all they can understand. There are also problems understanding people with pronounced accents, heavy colds, etc. It is very slow and rather unreliable, but it is undoubtedly the way of the future.

**Pulse Input.** This is the way rotary dial telephones (and many of the earlier push button 'phones) work. An electronic tone is not produced - rather, you can hear a series of mechanical clicks - a different number for each digit. Push button 'phones that are decatic (use pulses) produce the same sound. Many Voice Processing Systems can detect pulses and interpret them, but they are not 100% reliable.

**Tone input**. Modern telephones use electronic tones to send information. As you dial a number, you will hear a tone for each number pressed. This method of sending information to a VPS is by far the most reliable. All new Telecom 'phones are of this type as are new public telephones and almost all of those available in stores. Many 'phones have a switch that allows you to use either tone or pulse dialling. Tone input is much faster than either of the other two methods and much more reliable. Touchtone 'phones also give you the advantage of two extra keys - the # and the *. These can be used to advantage during interaction with a VPS, particularly to indicate that input is complete, to have a prompt repeated or to correct typing errors. Interrupting a message being spoken and typing ahead is really only available with tone input. This feature allows the caller who is familiar with the system to ring, get immediately to the option they want, do what they want to do and finish the call - all in a minimum time and for minimum cost.

## 4. HOW DOES IT WORK?

Interactive Voice Response typically involves the following steps:

- The caller rings the VPS
- The VPS speaks messages and give the caller a list of options
- The caller enters the required option
- The VPS asks for information
- The caller provides it
- The VPS interprets it, decides what has to be sent to the host computer and sends it

- The host computer takes the data provided, does what it has to with it and sends data back to the VPS
- The VPS interprets the data received from the host computer and speaks information to the caller.

The interaction is very similar to using a terminal on the host computer system. The keypad on the telephone replaces the keyboard on the terminal and the spoken voice in the telephone earpiece replaces the text on the screen of the terminal. The VPS handles the necessary translation in between.

## 5. WHAT TELEPHONE ACCESS IS REQUIRED?

The VPS can be connected to the telephone system in any of a number of ways, depending on the service you wish to provide to your clients - your students.

- **Normal** 'phone access works fine for students who live in the local area, but can be very expensive for those who may wish to use the service from a distance.
- **008** service is fair on all students but means that the institution pays all the costs of calls.
- **0055** will cost the caller according to the length of the call, but the charge will be the same per minute from anywhere in Australia. The cost can provide an incentive for efficient use of the system, thus avoiding clogging by callers who are 'wasting time' on the system. It can also provide revenue to help defray the costs of maintaining the system.
- **Direct Indial** (DID) can be used with any of the above systems and can pass the last few digits of the number called through to the VPS - useful in a shared system so the VPS knows which application to connect the caller to.
- There are also other methods of access through the telephone system - Telecom can provide advice on them.

## 6. HOW BIG DOES THE SYSTEM NEED TO BE?

The size of the VPS required will depend on a number of factors. You will need to choose a critical period when the system will be heavily used and, for this period, estimate things such as:

- the number of students who will use it (ns)
- the average number of calls per student expected (nc)
- the average duration of a call in minutes (cd)
- the number of hours per day that the system will be available (hd)
- the number of days in this period that the VPS will be available (d)
- whether or not a call scheduling system will be used?
- whether or not the system is shared or dedicated?

The system size can be estimated as follows:

usage (in hours) = (ns x nc x cd)/60
availability (in hours) = d x hd
Number of lines = usage / availability

For example, in a 3 week enrolment period:
A group of institutions with a total of 150 000 students (ns)
Average calls expected per student is 3 (nc)
Average duration of each call expected to be 4 min (cd)
Hours per day the system available is 18 (hd)
Days in the period the system available is 21 (d)
Usage = (150 000 * 3 * 4)/60 hours = 30 000
Availability = 21 * 18 hours = 378
**Required lines = 30 000 / 378 = 80 lines**

## 7. WHAT ARE ITS USES?

The uses of Interactive Voice Response in a Tertiary Institution are limited only by the imagination. Some examples are:

- an information or help line
- to inquire about enrolment or preference details
- to change enrolment or preferences
- to follow the progress of a tertiary application
- to accept or reject an offer
- to enrol or re-enrol
- to cancel enrolment
- to notify leave of absence
- to pay fees and charges
- to find results
- to order an academic transcript
- to find a personal exam timetable
- to apply to graduate or provide graduation information
- to vote in elections

## 8. WHAT ARE ITS LIMITATIONS?

The limitations of the current IVR technology are:

- You will need a touchtone 'phone for most effective use
- There are problems in entering alphabetic characters - codes can be used but these are clumsy and slow - it is probably better and certainly easier to stick with strictly numeric codes, even if this means having a set of codes just for IVR use.
- You will need to accommodate hearing impaired students - this is probably best done by providing a service at your institution for these people - have someone on hand to help them.

## 9. WHAT ARE ITS ADVANTAGES?

The advantages of IVR are significant and are the reasons that the relatively large upfront capital cost to the institution of installing IVR equipment is well and truly worth it. Some of the more obvious advantages are:

**Your student data is more reliable and timely** - students have access to their own information and can ensure that it is correct. They are the ones who have the most reason to ensure it is accurate. Once they authorise a change to be made, it is done - there is no delay waiting for forms to be processed (or misplaced). In critical enrolment periods, all the data is on the system at the deadline - there is no delay waiting for forms submitted at the last minute to be processed.

**Students are responsible for the accuracy of their own enrolment** - no longer is there the *I submitted a change form* and *we did not receive it* debate. The student has access to their information and the ability to get it right (within the normal rules). The responsibility has been moved from the administrators to the students.

**Payment of fees and charges can involve a direct funds transfer** - once the system tells the caller that the payment has been accepted, the institution actually has the money. This obviates the following up of dishonoured cheques and payments that cannot be identified.

**Students know changes have been made** - they no longer have to submit a piece of paper and hope that it gets processed. Once the IVR system says that the change has been made, it has. They can check at any time to ensure that things are as they should be.

**Problems are picked up early** and the student knows about them. If a student tries to enrol in a course that is not offered, or enters an incorrect course code, the system will tell them on the spot and disallow the operation. They will know that there is a problem immediately and can follow it up straight away.

**IVR is eminently convenient** - students can have access to the institution's computer system from home, the car, the beach, the pictures - in fact from almost anywhere - and almost anytime (on our system, 20 hours a day 7 days a week). Most transactions can be concluded in the ads during the movie or the football.

**IVR is cheap** - even on a 0055 number, doing changes over the telephone is probably cheaper than getting in the car or a bus and travelling to the Institution and back.

**Savings in casual labour**. The savings in data entry time can be enormous, as can the savings in time involved in chasing up errors made on forms by students - they will know their enrolment is not correct when they tried to enter the error and will have a vested interest in following it up to ensure that things are put right.

## 10. SUMMARY

Interactive Voice Response Technology is the way Tertiary education administration must move. It has the potential to radically alter the way we administer our clients. From the institutional point of view, it will result in significant cost savings as well as allowing us to work with data that is more reliable, timely and up to date. From the students point of view, it will give them ready, convenient and reliable access to their own enrolment information, as well as the ability to fix it if it is wrong. It will put the responsibility for a student's enrolment squarely on the shoulders of the student and give them the ability to manage it within the normal administration rules of the institution. It will give more power to the students - the power to control their own enrolment and get it right - something we are often blamed for being unable to do.

## 16

# CASMAC - A Co-operative Approach to University Administrative Computing

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### Abstract

CASMAC, or Core Australian Specification for Management and Administrative Computing, is a project of Australian universities to develop first a specification and then integrated functional systems to meet 80% of administration computing needs in the major areas of finance, human resources, physical resources, research and consultancy, student records and executive reporting. The paper gives an account of the project to date and comments on the issues arising from such a co-operative venture in software development.

## 1. INTRODUCTION

There is currently under way in Australia a consortium approach to the development of university administration computer systems, which is proving an interesting experience for the universities and the commercial software houses involved. The issues arising in project management are testing both sides, as it is a rare occurrence for the universities to contract for software development, most systems being written in-house or bought as a package.

Keyword Codes: K.6.1, K.3.1, J.1
Keywords: Management of Information Systems; Project and People Management; Computer Uses in Education; Administrative Data Processing

## 2. THE CASMAC SPECIFICATION

In 1990 the Australian Vice-Chancellors' Committee (AVCC) which is the co-operative forum of the heads of the 36 Australian universities, undertook a project to create a common specification for the core administrative computing systems required by universities. The project and the specification are known as CASMAC, Core Australian Specification for Management and Administrative Computing.

The project is a response to the perceived waste of resources involved in each university in Australia developing its own set of administrative systems, when there is a great deal in common across the institutions. It is also true that there are some differences between institutions, and so the aim was stated conservatively, to produce a specification for the core 80% of each application. The Commonwealth Government also has an interest in university administrative systems, as these are the source of the ever-increasing quantities of statistics and records that the Department of Employment, Education and Training require from institutions. There had been some friction between DEET and institutions over the workload involved in meeting the DEET requirements, in particular the changes to the data collection that occur virtually every year at short notice. On occasions, some institutions declared themselves unable to meet the DEET requirements because it was too difficult or costly to modify their computer systems in the time given.

The Government publishes a data dictionary of its requirements, and it agreed to provide some funding for the CASMAC specification provided that its data needs were incorporated.

The notion of CASMAC is based on an initiative in the United Kingdom by the University Grants Committee in response to concern about the quality of data provided to it by universities. The first step of the Australian project was to examine the UK specification, referred to as the "MAC blueprint", and to use it as the starting point for the Australian specification.

The CASMAC was drawn up by working groups of expert staff drawn from Australian universities, under the control of an AVCC Steering Committee. CASMAC version 2.0 was provided to universities in late 1991, and as a result of feedback from them, was reissued as version 2.1 in November 1992.

The specification covers the five major applications of

Finance
Human Resources
Physical Resources
Research and Consultancy
Student Records

The specification consists of data flow diagrams, data model diagrams and a data dictionary. It also specifies the requirement for an Executive Reporting function which will enable the combination of data from all five applications.

The AVCC not only adopted the CASMAC version 2.1 as a specification that all Australian universities could be expected to meet (over time) but also undertook to maintain the specification, in particular updating it regularly for changed government requirements. In this respect, the Australian project has gone beyond the UK one, where the MAC blueprint has been only a starting point.

The first major revision of the CASMAC is about to commence, to incorporate all the agreed amendments and additions identified through the experience of the Universities in embarking on the implementation of systems based on the CASMAC.

## 3. THE DEVELOPMENT FAMILIES

Building on the achievement of the CASMAC specification, the Australian Vice-Chancellors agreed to take the next step and invite commercial software providers to tender for development of the applications in conjunction with groups of universities.

A number of factors were suggested on which universities might group themselves, including location or type of institution, but the software environment proved to be the deciding factor. In the light of the tenders, and given the number of institutions involved, two "families" were established, UniPower, based on Powerhouse software and UniOn, based on Oracle. In both cases the commercial software houses had been involved in the UK MAC system developments.

Each family has been set up as a company, operating under a contract with the commercial supplier. There are 19 universities in the UniPower family and 11 in the UniOn, with a few universities preferring to stay with their own systems.

## 4. EXPECTED BENEFITS

A major factor in universities choosing to join a family is that the cost to receive all five applications is less than half the kind of costs institutions have been incurring through in-house development. Part of this cost saving is the economy of scale, helped by the substantial contribution the government is making. This was conditional on a very large number of institutions joining the development project, and led to a certain peer-group pressure to join.

In addition to the development cost saving, there is also the expected saving in a consortium approach to modifications in the future, in particular the need for regular changes to meet the government's demands. These relate not only to statistical reporting, but increasingly to operational matters including the collection of a charge for university education, which can be deferred as a future taxation liability.

The advantage of having an integrated set of systems, enabling easy executive reporting, is the other major benefit for universities. With the existing in-house development, there is a cycle of sequential application replacement over such a period of years as to ensure that technology has moved on a good deal between the oldest system and the latest, so that assembling data from multiple systems is extremely difficult.

Unlike the UK situation, most institutions in Australia have at least two or three of the application systems being offered in CASMAC already developed to a relatively high degree of functional and technological sophistication. Physical Resources systems are the least widespread. However, most institutions feel they will be sacrificing at least one better in-house application system for the benefit of taking the full CASMAC set of applications.

While there were a core group of institutions already using Powerhouse and Oracle software, many institutions are abandoning other software bases to join one of these two families. Each of the successful software houses has had to undertake to make their systems operational over a range of hardware platforms and operating systems.

## 5. EXPERIENCE TO DATE

The author's university is a member of the UniPower consortium and the following points relate to that experience.

The first phase has been to develop the Initial Specification for each of the five applications, expanding the CASMAC specification, and the last of these is almost complete, with the earliest now well into the Detailed Design phase.

A team consisting of a few user experts from among the universities, one information technology professional from the universities and one from the commercial company, has been set up for each application. There are also teams for Executive Reporting, Quality Assurance and Standards, Integration and Testing, and Implementation, Training and Documentation.

### 5.1. People problems

For each application, a university has undertaken to be the lead site, providing the chairman and secretarial support, a location for meetings and facilities for testing. For one application, the university who undertook the lead site role subsequently found itself unable to continue just as the intensive Initial Specification phase was about to start, and the author's university was pressured to accept this responsibility. Now the staff member who was chairman has resigned from the university only a few weeks into the project, but it is expected that a satisfactory substitute can be found. Other teams have remained stable to date.

The commercial company has had difficulty recruiting information technology staff of appropriate calibre who have some knowledge of the applications, especially those of Student Records and Research and Consultancy which are unique to tertiary education institutions. They have been forced to use one person to cover two applications, requiring some slippage in the schedule.

### 5.2. Size of project

The commercial company has further needed to extend the schedule because of its mis-estimation of the amount of work involved in the project. The delivery date for the last of the applications on the base hardware/operating system is now September 1995, compared with April 1995 in the initial contract.

The company has based its bid for the contract on being able to use its British MAC products as the basis for most of the Australian ones. Having seen the full Initial Specification for the Student Records system, it has realised that the Australian requirements are more different than it had understood. The need to write this application from scratch has caused further slippage in the schedule.

Other applications are also proving larger than the company envisaged. The contract requires that any additions to the applications (requirements not mentioned in the CASMAC) are to be paid for above the contract price, and a few such variances have been identified. Most notable is the omission of an assets register from the CASMAC, perhaps because finance staff assumed it was in the Physical Resources application, and vice-versa.

However, the commercial company has been identifying an extraordinary number of variances (134 at one stage in the Students Records application) and this reflects the gap in understanding between the universities and the company in the interpretation of the CASMAC. Universities are having to learn to give way on particular functionality that is not of interest to the whole group, but to a greater extent the company is having to expand its ideas of the requirements.

The UniOn family believed from the outset that its commercial company, which also tendered on the basis of MAC products, had under-estimated the differences and would do better to incorporate some third-party products already in use in Australia. They have completed their initial specification phase using their own resources and prior to contracting with their company in the hope of avoiding the problems the UniPower group has run into.

### 5.3. Definition of core systems

It has been clear from the outset that a definition of a core specification covering 80% of an institution's requirements was dangerously vague. As Powerhouse provides powerful reporting tools, the universities can readily add their own reports, or modify those provided in the core. Some initial thinking was that very few reports would be provided, and this would constitute the 20% institutions provided for themselves, but many reports are in fact included in the Initial Specifications.

The Executive Reporting "application" has always been vague, referring primarily to the availability of software reporting tools, and the team is still struggling to identify whether any actual reports will be provided under this heading, and whether an extract database for executive reporting will be provided. Many institutions see this latter as a necessity as they do not have the hardware resources to support free interrogation of the full integrated database.

To achieve the advantage of receiving timely modifications from the company after implementation in response for instance to government requirements, it will be essential that any additions of individual institutions to the core systems be in the form of separate sub-systems. Institutions cannot afford to insist on local customisations affecting the structure of the database. While this point is understood in the author's institution by the administrators as well as the information technology staff, there is expected to be some difficulty in persuading academic staff that the sacrifice of some complexities in course and subject structures, for instance, is worthwhile to facilitate the institution's response to government demands.

### 5.4 Design issues

The aim of implementing the CASMAC specification is to achieve a fully integrated set of application systems. The first requirement is a fully integrated database and to achieve this, a Base System is being designed.

It has been proposed to have a single person table, to provide basic data on each person known to the system, be they student, staff, debtor or hirer of facilities. This raised the question of who would maintain the data, as university administrations are divided into separate divisions of student administration, personnel, finance and physical resources, each accustomed to maintaining their own records.

This design has been agreed to be too radical to fit into current organisations, and there is instead to be a person master index, to link different records with different id numbers relating to the same person across applications.

The design still includes a single organisation structure table with common organisational unit numbers and names (faculties, schools, departments). A maximum of seven levels of organisational hierarchy is being allowed. This common organisational unit coding is important in providing standardised data to the Government and being able to draw data together across different applications for internal management information.

The university technical staff involved in the project have been critical of the commercial company's lack of sophistication in use of a relational database management system. This came to the surface in a dispute over the use of "triggers" to perform an action when the database is changed. This is seen by the university staff as a secure and efficient way to achieve an audit trail, rather than including such code in each application program. Such issues reflect the fairly advanced technical state of administration computing in at least some universities in Australia, and have clearly not coincided with the expectations of the commercial company.

On the application side, the sophistication of the systems expected has also been beyond the assumptions of the commercial company. The notion of systems relatively free of paper is accepted in at least some institutions, leading to a demand for all applications to maintain the history of values in key tables. This went without saying on the user side, and has led to arguments over whether this constituted a variance to the CASMAC in each application.

### 5.5. Training

A matter of considerable debate at this stage is the provision of training, in the Powerhouse products and in the applications when available. Universities being in the business of teaching, and that largely free of charge, there has been an adverse reaction to the charges proposed to the consortium, in particular by the software supplier, and a belief that the consortium could provide its own training more effectively. Some universities favour a train-the-trainer approach, where a few key people will receive commercial training and then pass it on within the institution. One or two universities see themselves as substituting for the supplier to sell training to their fellow institutions, at a lower rate.

## 6. CONCLUSION

No doubt there will be many further issues that emerge from this project, which represents an unusual attempt for universities to co-operate with each other and a commercial company to achieve a major project in the use of information technology in educational management. To date it has been a learning experience, not least for the commercial company.

# 17

## DUX : A remote-access on-line information system

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### Abstract

One of the aims of academic administration systems is to provide a variety of services to students. These services, however, normally require the attendance of the students at the institution and the presence of administrative staff to effect the transaction.

Deakin University has installed a voice-response administration system to allow certain functions to be initiated by students over the public telephone system 24 hours per day, 365 days per year. This paper discusses the structure of the system and describes its method of operation.

Keyword Codes: H.1.2; H.3.5; H.5.2
Keywords: Voice-response Systems; Remote User Access, Academic Administrative Systems

### 1. BACKGROUND - THE STRUCTURE OF DEAKIN UNIVERSITY.

Deakin is Australia's sixth largest university, with a total student body in excess of 26,000. The university is situated in the state of Victoria and has five campuses. Three of these campuses are situated in the eastern suburbs of metropolitan Melbourne, Victoria's capital city, one is situated at Geelong - one of Victoria's largest regional centres located some 70 kilometres from Melbourne and the remaining campus is at Warrnambool, approximately 250 kilometres from Melbourne.

Deakin has a large off-campus enrolment, enabling students to study in distance education mode from any part of Australia or overseas. Deakin has off-shore study centres in Malaysia and Hong Kong.

Deakin also has a large involvement with a number of professional bodies, including the Association of Professional Engineers and Scientists of Australia and the Australian Society of Certified Practising Accountants. The university provides course delivery and examination facilities for these bodies and their candidates are enrolled as external students of the university.

All of this makes for a large commitment of resources to enrol students, make changes to their enrolment details, disseminate examination results and field enquiries. Given the geographical dispersion of the student body (some serve onboard ships), there are problems relating to students' being able to attend one of the campuses to transact their business with the university, being able to check on exam results, etc. These problems are partly related to distances and partly related to time zone differences, the latter causing problems even for normal person-to-person telephone operations.

The means by which Deakin has chosen to provide at least a partial solution to these problems is to make use of the telephone technology which is available 24 hours per day for 365 days per year on a world-wide basis.

This technology , in the form of electronic mail, has been used in the teaching and learning process for a number of years. Its introduction to administrative systems, at least within Australia, is relatively new.

## 2. DUX - THE SOLUTION

DUX, Deakin University Exchange, provides a means by which students may access certain administrative functions by telephone using either touch tones, dialling or voice recognition.

A menu of ten operations is currently provided, see Attachment 1. On dialling the DUX number a recorded voice asks the caller to transmit the number "one" to ascertain the technical capacity of the caller's handset. The caller may then transmit their response by touching the 1 button on a touch-tone handset, dialling 1 on a decadic handset or by speaking the word "one". The DUX system will then branch to a routine which will communicate with the caller in their chosen mode of operation.

A recorded dialog leads the caller through the steps needed for the operation selected, including multiple prompts if errors are detected in responses.

The DUX system provides the caller with on-line access to the university's database in the same manner as would be provided for an internal, staff operator. Students are able to interrogate their examination results, to add and/or delete units in which they are enrolled and to obtain a statement of the units comprising their current enrolment. In a menu selection not yet implemented, they will be able to quote a credit card number for the payment of their fees.

A function about to be implemented will allow callers to record text data, such as changes of address, to be acted upon later by operators who retrieve the message and manually enter the required data.

## 3. SYSTEM SECURITY AND LIMITATIONS

Some of the considerations involved in using the system are inherent in the current state of the art of the technology and others are the result of its mode of operation.

Given that the ideal vehicle for interaction with a system such as DUX is the touch-tone telephone, Australia's current 15-20% of touch-tone phone penetration is the largest single impediment to a wider use of these applications. This is changing at a steady rate and will eventually be a minor irritation only.

One limitation imposed by the technology is the necessity for all input to be numeric. While it is possible for touch-tone phones to signal alphabetic characters by the use of the numeric keys, the practical difficulties of differentiating between numeric and alphabetic input mean that, for practical purposes, the system is limited to numeric input. This necessitates all information to be coded entirely in numeric terms.

Spoken input could offer a means of overcoming the limitation to numeric input only. There are difficulties, however, with voice recognition and DUX voice input is limited to the spoken digits 0 to 9 together with "yes" and "no".

The basic assumption on which the system is predicated is that students are basically responsible people and that they will assume liability for their actions. If an enrolment is altered capriciously, the student will be the ultimate loser in the long term. Each student has a personal identification number, or PIN, which provides them with the means of protecting the integrity and confidentiality of their data. This PIN is initially set to a 4-digit number comprising the day and month of the student's date of birth. Students are encouraged to alter their PIN (menu choice 1) as often as needed to preserve the security of their information.

Transactions involving the change of a student's enrolment have implications related to course regulations concerning numbers and types of units able to be taken, together with the satisfaction of prerequisites, etc. In order to minimise the connection time of any one transaction, such changes entered via DUX are processed without validation during the on-line operation. They are then subsequently checked in batch mode and potential errors are detected. These changes, highlighting any anomalies, are included on a report which the system automatically produces for the academic staff. If the staff wish to query the transaction, they may use the DUX system to generate a letter which is produced and mailed to the student, indicating the existence of a potential problem. At the same time, a future reminder notice is placed on file and brought to the staff member's attention in due course to remind them to follow up the transaction and determine whether or not any corrective action has been taken by the student. If none has been taken, the staff member may countermand the student's original action.

For operations which may potentially be undertaken by all students at the same time, such as re-enrolments, the students are allocated a time slot for their use. Students attempting to effect such a transaction outside their allotted time are automatically denied access to that function. This measure was introduced only as a result of bitter experience. Several Telecom exchanges were brought down initially as the result of some hundreds of callers attempting to access DUX simultaneously.

## 4. TECHNICAL SPECIFICATIONS

The DUX system as configured by Deakin, see Figure 1, consists of 72 incoming lines split into 6 groups of 12 lines each. Each 12-line group feeds into the administrative information management system via two hardware units supplied by Alcatel. The first of these, a Vbot, determines whether the input is digital or spoken. If the information is spoken, the Vbot translates the voice input to its digital equivalent. Remember that all input is numeric. So, a spoken input of "one four zero six" becomes 1406. The translated value is repeated back to the caller by the Vbot and the caller is asked for "yes" or "no" to verify the number or to request a repeated input.

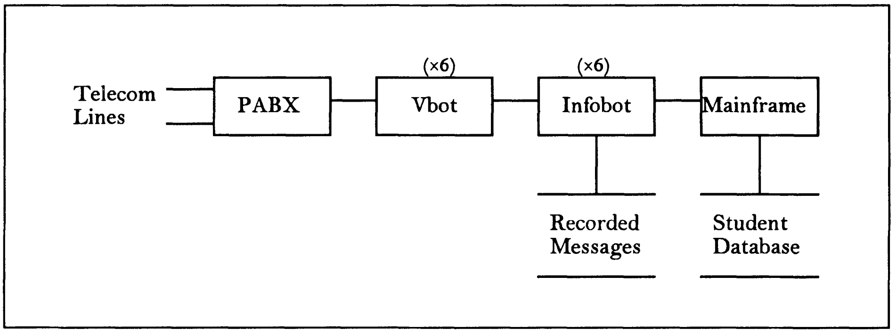

Figure 1 The components of the DUX system

In the case of an initial digital input from a touch or dialled phone, or the translated output from a Vbot, the input is next handled by the second of the hardware devices, an Infobot.

The Infobot has access to a number of digitally recorded messages which it uses to converse with the caller. Its essential function, however, is to take the digital input and to make it appear as input from a normal video monitor to the application software. Hence the application procedure which accepts a student ID number and function code from an operator, accesses the student database and replies with a list of subject codes or exam marks is unaware that the origin of the enquiry was from a telephone rather than from an operator at a screen. It is similarly unaware that its displayed output is being interpreted by the Infobot and converted to spoken form over the line to the caller.

The input/output operations are therefore isolated from the database access and update operations. The university's database management system is about to change from UNIFY to ORACLE and no alteration to the DUX interface will be needed.

It is significant that the programming of the Infobots was carried out by one of the student administration staff rather than needing the resources of the central computing staff.

## 5. THE ADVANTAGES OF THE DUX SYSTEM

The advantages as seen by the university are :

For students :

- The service is accessible from wherever the student happens to be.
- The student has 22-hour access each day to enrolment details. (The other 2 hours are devoted to database maintenance functions.)
- Students can make changes right up to the associated deadline.
- Students have control over enrolment details at all times.

- Students do not have to attend the university to enrol or to change enrolments, saving loss of working or leisure time.
- Queues on enrolment days are eliminated or reduced.
- It is a paperless transaction. The trees thank you.
- Long-distance telephone calls may be made at nights, taking advantage of cheaper rates.

For the University :

- Changes in statistical data are reflected immediately, eliminating the delays associated with manual keying of data.
- Class lists are up to date and available to staff promptly.
- Enables early ability to predict class enrolment numbers.
- Reduction in mail handling and postage charges.
- Reduction of congestion on enrolment days.
- Saves tying up staff to process enrolment changes.
- Elimination of lost paperwork and errors in processing.

## 6. CONCLUSION

Very few Australian educational institutions currently have systems as sophisticated as DUX. In its operation, however, the telephone interface to the conventional database functions is both easy to implement and simple in its operation.

Deakin is currently looking to a number of other administrative areas, such as student and staff elections, in which to utilise telephone input.

The technology and method of operation used in DUX will become refined and simpler to install and use within the immediate future. It provides clear advantages to both the provider and user of computer-based services.

# DUX

DEAKIN UNIVERSITY EXCHANGE

# Easy as using your phone

Deakin University Exchange (DUX) is the University's convenient phone-in service for students.

Within the next twelve months DUX will be providing a wide range of services:

- adding units
- deleting units
- assessment results
- variations to enrolment
- payment of fees and charges
- supplementary assessment detail
- examination centre information for off-campus students

DUX services will soon be available to all Deakin students. Mid-year assessment results will be available through DUX for students on all campuses from 16 July. For on-campus students re-enrolling for 1994, DUX will be the accepted method of re-enrolment.

For students who do not have access to a "keypad" telephone, voice recognition technology is provided, with DUX interpreting the spoken commands of the student. The voice recognition technology is being further refined and adapted to local requirements.

All transactions are printed and mailed to students as confirmation.

Touch-tone (keypad) telephones have been installed in prominent locations on each campus. Calls to DUX on these telephones is free of charge. A tutorial DUX DEMO facility is available for people wishing to sample DUX.

DUX is secure because students access it via the student ID number and a personal identification number (PIN) issued to each student. Security is maintained because students are able to use DUX itself to alter the PIN. Re-enrolling students are guided in the selection of their units by face-to-face consultation with faculty staff, and by a Course Re-enrolment Advice Sheet which sets out clearly the structural details of the course. These details are provided by the faculties to enable Student Administration to print and distribute the sheets.

The students' unit selections are provided to Faculty Enrolment Officers in the form of an Audit Report which includes a copy of the student's academic history, a listing of the current units selected, and an alert if any audit checks have failed.

DUX can monitor such things as credit point loadings per semester, and can limit cross-mode, cross-campus and cross-faculty enrolments as required.

Information about DUX will be released progressively as developments occur. DUX information presentations will be conducted on all campuses in the second half of 1993.

For further information about DUX, contact Student Administration at Burwood, Geelong or Warrnambool. DUX can be sampled by dialling into the DUX DEMO (menu choice 6).

**The Dux Menu**

0 Exit
1 Change PIN
2 Add units*
3 Delete units*
4 List of units enrolled in
5 Assessment results
6 DUX demo
7 Change address*
8 Pay fees*
9 List menu choices
10 Obtain examination centre details*

**Currently being developed*

**DUX Numbers**

Geelong (052) 27 2121
Metropolitan (03) 244 6121
Warrnambool (055) 633 121

DEAKIN
UNIVERSITY

# 18

## The Queensland Tertiary Admissions Centre: An Example of a Cooperative System Using State Of The Art Technologies

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### Abstract

The Queensland Tertiary Admissions Centre Ltd (QTAC) faced a daunting challenge over the past two years in accommodating the new profile approach to the assessment, selection and admission of students to tertiary courses in Queensland. The solution involved the use of state-of-the-art technologies; three of these technologies are discussed.

Keyword codes: H.5.2; I.2.1; C.2.4
Keywords: User Interfaces; Applications and Expert Systems; Distributed Systems

## 1. INTRODUCTION

The Company used as the case study for this presentation is Queensland Tertiary Admissions Centre Ltd (QTAC), which is a company limited by guarantee and was established by the six State universities of Queensland. Its Directors comprise the Chief Executive Officers of universities (the Vice-Chancellors), the Director-General of Education and the Chief Executive Officer of the Company (the Managing Director). To understand the context in which QTAC has embraced State of the Art Technologies in a cooperative venture, some background to its history and culture may be helpful.

The Company has been in existence, pre and post incorporation, for 18 years now and during this period it has implemented 3 very major systems developments plus a host of sub and auxiliary systems developments. Starting in the mid 1970's as an operation that was as much clerical as computerised, by 1985 it was able to introduce the first (and very major) interrelational data based systems available in its industry. It provided on-line interactive access to its data base by all its member institutions, firstly via AUSTPAC and later AARNet. Up to 1992, QTAC systems have run on The University of Queensland IBM 3083 or its predecessors, with technical and computing expertise provided through contract by The University.

These days, QTAC handles applications for entry to the 7 State funded universities and 32 technical colleges in Queensland. It operates the most highly sophisticated computer system based around 75 SUN desk top workstations and X-Terminals running INGRES Windows4GL applications in client-server mode against a central INGRES database on a SUN SPARC Centre 2000. The systems run over both local private networks and the Australian universities national network (AARNet). A 96-line Periphonics Interactive Voice Response System provides clients (which includes tertiary institutions and student counsellors as well as students) with telephone access to information services and to QTAC's central applicant database.

There are many major features of QTAC's system worth exploring; in the time constraints, however, I will briefly outline just three of these.

## 2. PAPERLESS APPLICATIONS FOR UNIVERSITIES AND TAFE ADMISSIONS (OR THE "ELECTRONIC APPLICATION FORM").

The first significant development in QTAC's State of the Art Technologies was the provision of a sophisticated PC-based method by which Queensland Year 12 students apply to QTAC for places in tertiary courses.

There are many benefits of this innovation, some major ones being:-

*to Year 12 students*

- more timely and appropriate information is provided as part of the application process which should assist students in making better course choices. Parts of the system replicate QTAC's publication, the *Queensland Tertiary Courses* with any changes to courses since publication incorporated. Students can, while entering their choices, select from institutions and courses and are automatically presented with the prerequisites, interview requirements etc.
- on-line help is available to the student for each field and action required.
- all required codes and code descriptions are provided on-line and only valid codes are accepted. In the past, 15% or more of students had course duplication and course coding inaccuracies on their initial application.
- students are presented with questions that only pertain to their circumstances, for example, those that answer 'no' to the question 'Have you completed Year 12 studies previously?' are not then asked questions about previous study.
- students are prompted where additional action is required, for example, to supply documentary evidence.
- up until the time that the school administration uploads their data, students can change or reorder their preferences as many times as they wish.
- experience has shown that students enjoy using the new technology.

*to Schools*

- less postage and paper handling and avoidance of "lost" forms.
- faster response time from QTAC for acknowledgment of receipt of the applications.
- time savings for school guidance and counselling staff.

*for QTAC*

- reduced printing, mailing and file storage costs.
- replacement of keyboard data entry of Queensland school-leaver applications by fast uploading from diskette.
- greatly reduced time in entering applications means that earlier information is available to educational planners regarding the patterns of course applications.
- only 'good' data is collected, for example
    - students can only select valid course codes and because they are presented with the prerequisites for that course automatically, are more likely to select courses for which they do meet prerequisites
    - preferences cannot be repeated in the list of six available preferences and gaps are not allowed

- information is checked to ensure that it is either one of a number of valid entries or is within an allowable range, and if not, immediate action is required by the student
- data entry keyboard errors are avoided
- errors caused by poor handwriting are eliminated.

In view of the many efficiencies and savings that the electronic application form has achieved over the past 3 years, further development is planned to enable extension of the facility to other categories of applicants, such as those already studying in member institutions and Year 12 students from non Queensland schools.

## 3. GRAPHICS BASED INFORMATION SYSTEM

Soon after a report reviewing tertiary entrance procedures was made in June 1990, the Queensland Government had accepted all of its principal recommendations. The consequences for QTAC promised to be and subsequently became the most challenging of all the changes it has had to embrace.

The Company chose to embrace graphics based information systems in its new systems design for the following reasons:-

- the new profile approach to tertiary entrance heralded by the reforms presented what appeared and may well be the most complex and advanced system of tertiary applicant assessment and selection in this world - in regard to both humans and computers
- an early assessment indicated that at least twice the size of applicant data overall would need to be collected by QTAC (in fact it proved to be 10 to 12 fold)
- it meant the application of up to 620 course specific complex rules to derive the one or more (up to 8 in experience) rankings for each of 70,000 applicants for each of their, up to 6, course preferences (with changes of preferences this means up to 1/2 million preferences in any annual admissions period)
- the new system as outlined claimed to be but the beginning; it assumed a further evolution of (mostly unknown) changes that would occur soon after the new system was implemented (e.g. use of school principals' reports)
- on second assessment, it became clear to QTAC that what was needed was an 'expert' system
- it was clear also to QTAC that the systems we were accustomed to, whilst recognised as large and hard for a novice to readily understand, would be changed to something so complex that none, not even the inventor would find simple or easy to understand.

In other words, it was understood that to achieve a fairer tertiary entrance system, a far greater complexity had to be introduced. Thus some major questions QTAC asked of its technical expert consultants were -

- How do we acceptably present new systems that are even more complex than the current systems?
- How can we ensure that users in institutions including for example Deans of Faculties with little time and no opportunity nor desire to familiarise themselves with QTAC's operations before the busy admissions/enrolments system hits in December/January, tolerate these changes?
- To present a system that would be so complex and difficult to understand and be able to interpret correctly the vast new data elements and corresponding terminology inherent to the new profile approach surely would be too tall an order to place on staff in institutions (i.e. the users)

who had cooperated so fully in the past and were exemplary in the use of the existing systems. Surely they would resent the change.

QTAC's technical advisers proposed, in response to our queries or concerns, the use of Graphics Based Information Systems. In non-technical terms, to the user the benefits of Graphics Based Information Systems (or GUI) included quite simply:

- an easier way to understand complex computerised information with data explained on-line in plain language
- friendlier presentation of this complex data, allowing essential data to be highlighted
- use of scanned images of documents etc. (i.e. a picture paints a thousand words)
- a fool proof way of not ignoring important information - it hits you in the face or warns you
- a vastly improved correspondence system that permits graphic headings, scanned personal signatures and bar coding to enable fast receipting of responses.

It was clearly evident that QTAC should aim for a GUI system. Experience has subsequently vindicated the decision.

QTAC believes that it would not have been possible to manage the volume of data generated by the profile-based admissions systems without employing the techniques available with graphics-based systems. It also believes that a graphics-based information system gives it the capacity to cope with whatever may in the future comprise assessable elements within the admissions process. The success of QTAC's new systems is testimony to the validity of those beliefs.

Many of the general benefits to any users of a GUI based system are multiplied for an admissions systems (as one would expect for any student enrolment system or indeed for any other "seasonal" activity). The process of admissions occurs over relatively short but intense periods, normally only once or twice each year. When admissions are not being processed, the core functions supported in the admissions computer system are not used. For most staff, a period of six to seven months passes without the need to venture down the admissions menus. As a result, users' knowledge of the admissions system is lost or at best severely diminished. Re-training is required every year.

To compound this problem, a number of temporary staff is recruited every year to help with admissions processing. The problem of training them in what is a very complex process is quite significant. However, compared to character based systems, users find GUI systems easier to learn, they accept the environment more willingly, they are more willing to explore within the system. A GUI system allows the system developers to provide an environment which encourages these traits, which provides guidance as to the state of processing and what has to be done next and which provides what we call active help for users.

Lastly on GUI, and most importantly, because the system is visually attractive there is and in our experience it has been proven, a much higher probability of maintaining interest and therefore increasing productivity.

## 4. AUTOMATIC RETRIEVAL OF TERTIARY RESULTS SYSTEMS (ARTS)

The third major feature I have selected to talk briefly upon, was implemented by QTAC in the most recent admissions period. This is the Automatic Retrieval of Tertiary Results System, known in Queensland as ARTS. ARTS has been a truly cooperative project between QTAC, the universities and the Headquarters of the TAFE colleges, involving complex specifications and programming at both the QTAC end and at the institutions.

Many thousands of applicants to QTAC each year have already undertaken tertiary study and are seeking to transfer to a more preferred course or to undertake a second degree. An important part of QTAC's work is the collection of the official academic records for these applicants as their tertiary results form an important part of their criteria for assessment for selection. Typically about 25,000 academic records must be obtained from member universities and from TAFE and the large bulk of these cannot be collected until mid to late December when end-of-year examination results have been recorded on the student databases.

This has therefore been a mammoth task each year, both for QTAC and for the universities and colleges. As the thousands of academic records came into QTAC they had to be matched with the applications.Staff then assessed the results, calculated grade point averages, checked on exclusion matters and so on and updated the computer files. All this work had to be undertaken in about 14 working days.

With ARTS, all the clerical work and mountains of paper involved in the task has been eliminated. Through the AARNet communication network QTAC now

- automatically generates and sends electronic requests for academic records to the universities and to the technical colleges
- an electronic scan of the institutions student databases creates electronic copies of the records and automatically returns them to QTAC
- the records are electronically attached to the applicant record
- GPAs and ranks are automatically calculated according the expert rules for each course listed by the applicant.

The efficiencies achieved by ARTS have exceeded all our expectations. In the first year, up to $200,000 were saved in clerical work at the QTAC end and similar savings would have been made at institutions. More importantly it shifted the peak of the computing work, some 1.2 million calculations on one day alone, from mid-January back to December, thus providing staff at QTAC and at institutions valuable extra time to perform checks and balances before the major offer round in mid-January.

ARTS has been one of the best examples of the benefits of cooperative systems and of State of the Art technologies.

## 5. CONCLUSION

The new information technologies such as those discussed here have enabled a tertiary admissions system to be introduced that can handle massive volumes of diverse data and highly complex rules in a sophisticated, efficient and user-friendly way. The new systems benefit all users within QTAC and within tertiary institutions. Most importantly, it benefits applicants by providing, for example, a "paperless application" that ensures that only accurate data is collected and the means for automatic retrieval of examination results as soon as they become available. QTAC is a fine example of how co-operative use of the latest technologies can achieve excellence.

# Contribution of the information technology/information systems to human resources management in the university

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## Abstract

This paper deals with the human resources department in the university, and it is focused on two different issues, both of them related to each other. First, we analyse theoretically the human resources in the organizations and how to develop the function of human resources in the Spanish public university environment, specifically in the University of Las Palmas de Gran Canaria (ULPGC). Second, we conclude with a Human Resources Department design in which we have in mind the main functions and activities to develop inside the aforementioned department, analysing the information needed and proposing an IS design to support the activities carried out in this type of department.

Keyword Codes: H.1.1; J.1; J.4
Keywords: Systems and Information Theory; Administrative data processing; Social and Behavioral Sciences

## 1. INTRODUCTION

This paper will describe the application of Information Systems and Information Technology (IS/IT) to management in educational institutions, and in particular in universities. It is based on an overall analysis which was undertaken with a view to discovering how IS/IT could contribute to improved management performance.

The main supporting framework was Porter's Value Chain [1], though it is recognized that this analytical tool has been subject to criticism because of the difficulty of adapting it to non-profit service industries [2]. Based on some one hundred in-depth interviews with senior university management (Rector Management Committee, Directors of various Centres, Heads of Departments, and Non-academic Support Department Heads), a value chain model was developed for the University of Las Palmas de Gran Canaria (ULPGC), which may in principle be applicable to any western type university.

This adaptation of Porter's model was not straightforward and considerable debate arose, e.g. over the role played by the students (raw material that undergoes transformations; clients requiring training; a productive element, taking part in their own education); and about what might be considered as the "profit" margin, i.e. social benefits, cost savings, etc. Nevertheless it can be said that with the aid of this model some priority areas can be identified and defined for the development of IS/IT in the university.

In order to test the findings resulting from the above approach, the Critical Success Factors (CSF) model was later applied independently [3]. Similar results were obtained. Five high priority development areas, or projects, emerged immediately and these were initiated simultaneously. The remainder, some six or seven further areas in which IS/IT might help management improvement, were held over for later research as, given their relatively minor importance in the university's value chain, their implementation was less urgent. In this sense it must be pointed out that the value chain has shown itself to be an enormously powerful tool for identifying areas of interest and for establishing research priorities.

From the five IS/IT development projects initiated in the areas of library services, student academic counselling services, department management, property management and human resources management, the last one was chosen for this paper as it constitutes a good example of how to identify opportunities for organizational improvements through IS/IT and how to implement them.

## 2. ANALYSIS

Human resources management is an area of particular interest because its proper administration has a direct impact on the overall results of the university, which is a human-capital intensive institution. The choice of an appropriate procedure becomes especially crucial when developing an IS to support that function. For this reason, the methodology followed in the development of this project is based on the Information System Life Cycle which, as has been shown elsewhere [4-7], is the most widely accepted in its different variants. Alongside this we have applied principles of structured analysis and design.

Thus, the first step involved a theoretical revision of those activities which, in the view of other specialists in the field [8-10], should be undertaken by a human resources department, in order to contrast them later with those which are carried out by the ULPGC and to test their level of implementation. The revision of the present system was not only done to highlight those activities which were either inadequately carried out or not at all, but also to consider the different ways information technology would improve each activity, especially by means of the latest advances in data-base technologies, communications, and multimedia.

The result of this research is summarized in Table 1, which brings together fourteen activities concerning human resources management in an organization. It shows the level of IS/IT use reached at the ULPGC and the development proposal which ultimately emerged. As can be seen, the already computerized activities are, in general, those most closely related to the administrative processes which are most strongly regulated in state universities, i.e. recruitment, selection, salary administration, and the social benefit plan. It is assumed that this is a general pattern in other universities.

On the other hand, for five activities -socialization, organizational development, motivation, health and safety, and human resources auditing- IS support provides no significant advantages compared to traditional ways of working. This may be the result either of the highly unstructured nature of the tasks, which makes their systematization difficult if not impossible, or of the ineffectiveness of systematized information in these cases.

Finally, four activities were identified -analysis and description of jobs, career development, performance evaluation, and training and development- for which substantial performance advantages could be obtained with the support of adequate information systems.

At this stage, an analysis of information needs for each activity was carried out based on a detailed study undertaken in conjunction with senior management of the Human Resources Department. From this study a list of system requirements emerged, serving as a cornerstone on which the design of the system was subsequently based. This involved the exhaustive analysis and description of the tasks to be undertaken in each activity in order to identify information needs related to content, availability, reliability, and styles of presentation. To this end a series of techniques and research tools were employed, such as interviews, flow charts, organization tables, job descriptions, direct observation, and the examination of the work of similar departments in other universities.

Table 1.
IS/IT support to activities concerning human resource management.

| HUMAN RESOURCES AREA | ACTIVITY | CURRENT STATE | PROPOSAL |
|---|---|---|---|
| Provision | Recruiment | AIS | |
| | Selection | AIS | |
| | Socialization | NO AIS | |
| Application | Analysis and job description | NO AIS | DIS |
| | Planning and forecasting | AIS | |
| | Career development | NO AIS | DIS |
| | Performance evaluation | NO AIS | DIS |
| Development | Training and development | NO AIS | DIS |
| | Organizational development | NO AIS | |
| Maintenance | Motivation | NO AIS | |
| | Salary administration | AIS | |
| | Social benefits plan | AIS | |
| | Health and safety | NO AIS | |
| Audit | Human resources audit | NO AIS | |

| | |
|---|---|
| AIS | Activity undertaken with IS/IT support |
| NO AIS | Activity undertaken without IS/IT support |
| DIS | Develop IS support |

## 3. TECHNICAL SOLUTION

At the macro-design level two alternative technical solutions can be proposed:

a) To develop autonomous information systems for the abovementioned activities, i.e. independent of other systems already implemented within the university.

b) To integrate the new systems with those already existing, using the data-base technology available in the university besides its hardware, mainframe and communication system infrastructure.

Although the choice of the second option, with greater integration and better use of existing resources, might initially seem obvious, the difficulty was that the university's systems run on a proprietary-brand operating system, while our project presented the opportunity to migrate to an open system. Once the pros and cons were evaluated, option *b* was finally chosen, mainly because most of the necessary data for the new systems would be shared with the one already running. This choice determined the grounding technology to be employed: that already in use within the university, namely, an IBM 9121 mainframe with 15 Gb on HD and 64 Mb of RAM; IBM 3745 communication unit, VM/ESA operating system and IBM's SQL/DS database management software.

It remained to design the structure of the data files on which the new system was to be based, including the relation between these and those already existing, as well as a computer application which would allow us to capitalize on the information as required in the analysis undertaken. Consequently, a four-module computer application was designed for structured information management which included querying, record creation, record removal, and record editing. The system's safety mechanisms were defined, including access authorization.

In Table 2, the main features of the eighteen resulting files are presented. Altogether they contain over 240 data fields.

Table 2.
Resulting files of the design stage.

| ACTIVITY | TYPE OF PERSONNEL | FILES |
|---|---|---|
| ANALYSIS AND JOB DESCRIPTION | STAFF | - Job-intrinsic data file<br>- Job-extrinsic data file |
| | FACULTY | - Generic personal data file*<br>- Job-intrinsic data file<br>- Job-extrinsic data file |
| CAREER DEVELOPMENT | STAFF | - Generic personal data file*<br>- Exclusive personal data file<br>- Subjective data file |
| | FACULTY | - Generic personal data file*<br>- Curriculum-vitae data file*<br>- Subjective data file |
| PERFORMANCE EVALUATION | STAFF | - Generic personal data file*<br>- Assessment data file |
| | FACULTY | - Generic personal data file*<br>- Curriculum-vitae data file*<br>- Student-survey data file |
| TRAINING AND DEVELOPMENT | STAFF | - Generic personal data file*<br>- Exclusive personal data file |
| | FACULTY | - Generic personal data file*<br>- Curriculum-vitae data file* |

* Data shared with other existing files in the university

## 4. ORGANIZATIONAL SOLUTION

A moderately ambitious IS development project that attempts to go beyond a mere mechanization of working methods generally implies certain changes in the way in which organizations operate: new tasks are created, previous tasks are done differently, work interfaces are different, and so on. For these changes to be accepted by the organization, it is essential both to study the proposed technical solution and to introduce the necessary organizational improvements. The risks of failure of the whole project are thus minimized.

In this context, and according to the theoretical framework for university organizations -the professional organization- proposed by Mintzberg [11] it was judged appropriate to give a certain autonomy to the Human Resources Department, at least in those areas less affected by current legislation, and in such a way as to incorporate it into the technostructure (an element of the organization not directly related to the operating core and support staff), while the activities of recruitment, selection, salary administration, and social benefit planning were assigned to the already existing Personnel Service (within the support staff, as shown in Figure 1).

This part of the project concludes with the organization design of the new Human Resources Department and the creation of the function guide for each job.

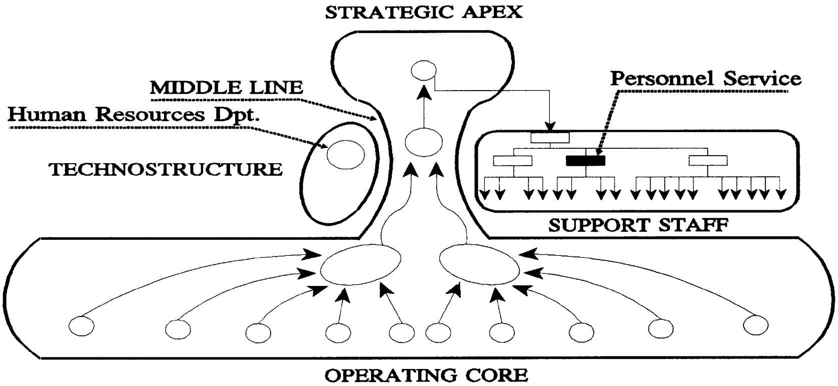

Figure 1.
Human Resources Department's location in the university structure.

## 5. CONCLUSIONS

As the University is an organization whose main productive factor is the human one, it is essential to pay particular attention to and monitor the activities related with the new Human Resources Department. In this project, this area has been considered as a part of an interdependent whole in which IS/IT provide clear possibilities for management support and improvement.

Both the research team and the ULPGC's senior management hope that the new model for the Human Resources Department (now being introduced) with its information support systems will have a positive influence in the improvement of academic and research productivity in the university mainly in two ways:

1) Increased motivation of all university personnel (faculty and administrative staff), as a result of a considerable increase in the efficiency of job analysis and description, career development, and training and development, for which there will be adequate and valuable information available from now on.

2) Greater control of tasks and individual productivity by university management. This will stem from the broader possibilities for more effective performance evaluation provided by the new information system.

Besides these improvements at the operational level, we need to consider those which, at the strategic level, may accrue as a result of decision-making based on more reliable, accurate and up-to-date information.

It is important to highlight the low costs related to this development, as projects involving IS/IT are commonly associated with major capital investments. In this case, the hardware does not exceed $15,500 -mainly for new intelligent terminals connected to the mainframe- and $15,000 in software -the cost of the development of the computer application for information management. This investment is relatively low if compared to the annual budget of over $103 million required by the ULPGC, an organization with over 1,400 faculty, and 600 administrative staff educating over 22,000 students.

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## PART FOUR

# Educational Decision Support Systems

# "SHESHET"* - Decision support system for guidance and placement of enrolling high school students

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## Abstract

Many high schools have to tackle the problem of placement of the students who want to enroll in them, and into tracks, classes and vocational programs. The decision-making process of matching between individual aspirations and the system capabilities is known to be complicated and ineffective. This paper describes a decision support system developed to assist the principal and the counselors in the placement process and the integration of the system in school.

Keyword Codes: H. 1.2, D.1.1, C.5.2
Keywords: User/Machine System, Applicative Programming, Minicomputers

## 1. INTRODUCTION

When students graduate from junior high school choices must be made with regard to high schools they want to enroll in, the kind of program (or track) they can select and the specific class they will be placed in. At the same time, the school principal, the counselors and the professional teachers have plenty of decision-making to do with regard to registration selection and placement of the new students.

The process of matching between the individual aspirations and the system capabilities is known to be complicated, intuitive, time-consuming and ineffective. The case of vocational programs is even more complicated as the decisions made by either side will, to a large extent, affect the future career of the individual student after school.

The problem at hand can be defined as an optimization problem: Is it possible to improve contemporary practices of educational decision-making in the guidance stage when junior high students opt for technology school, compromising between individual characteristics and school capability. This problem can be defined within the frameworks of the theories of adaptive education [1, 2] or effective schooling [3].

Since the decision-making process is so central to the abovementioned problem, we examined the possibility that utilization of an appropriate information technology to support the guidance process will improve it significantly.

Our approach was to develop and utilize a decision support system (DSS) based on individual and school data bases, a set of educational decision-making rules (elimination by aspects) to provide the school staff with a tool that would improve the placement process into vocational programs with clear and standardized criteria that can be justified. The DSS would improve the ability to comply with the individual needs, and increase administrative capacity. The advantage of our approach is that while the computer undertakes much of the information complex educational decision-making, it leaves both the criteria and the final decision-making in the hands of the school staff. We will describe the DSS developed and initial evaluation of the integration of the system in school.

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* "SHESHET" is the Hebrew for a decision support system named after Robinson Crusoe's servant Friday.

## 2. LITERATURE REVIEW

Computer Assisted Guidance (CAG) systems have been in existence since the early sixties. These systems can be broadly divided into three groups:

(1) Information retrieval systems - in which the task of the computer is basically to find the "page" on which the information required by the client appears.
(2) Information processing systems - in which the task of the computer is to identify educational or occupational opportunities which satisfy a number of criteria proposed by the client.
(3) Learning systems - which concern retrieval and processing of information in a way that helps clients to learn relevant skills and concepts [4].

Most CAG systems can be characterized as follows:

(1) The system includes data bases.
(2) The system includes interface for the user.
(3) The guidance is projected from the point of view of the individual and not from that of the educational system.

Existing systems do not include a broad decision-making component [5].

In the early sixties new possibilities were presented to computer users: new technologies offered quick access to data and information, and made it possible for the user to have a dialogue with the computer. This opened new horizons to managers of organizations and turned the computer into a tool capable of assisting in quick decision-making.

Simon [6] divided decisions into two types:

(1) Structured decisions, which are programmable.
(2) Unstructured decisions, which are non-programmable.

A decision is purely structured if the whole process of decision-making can be described in detail before the decision is made. The fact that a computer can make structured decisions just like human beings turns it into an efficient tool in making decisions of this type. Therefore, computer utilization in making structural decisions is widespread, the burden of making such decisions lifting off the manager or the person who was previously in charge.

Note that defining a decision as structured or unstructured is describing two extremes. In reality there is a wide spectrum of decisions ranging from purely structured to purely unstructured. Decisions which are partially structured and partially unstructured are called semi-structured decisions.

According to Gorry and Scott Morton [7], most of the important decisions made in an organization are semi-structured. These authors introduced the term Decision Support System (DSS) to describe systems made to support semi-structured decisions. However, while the computer's main contribution in structured decision-making is to increase the efficiency of the process, DSS help increase the effectiveness of decision-making itself. The main purpose of DSS is not, therefore, to save working hours, but to help in making a better decision.

The DSS supports tasks in which some of the functions are better handled by the system and others are better handled by the manager. The "SHESHET" system for guidance and classification of pupils is based on two models:

(1) Simon's model of "Limited Rationalism" [8]
This model assumes that the number of alternatives examined in the decision-making process is limited, and the one alternative most satisfying is chosen [6]. This theory is of great importance regarding the development of DSS, because of the unique nature of these systems which are based upon man-machine interrelations.

By definition, the DSS must lead to full cooperation between man and the computer during the decision-making process. The formal division of decision-making processes into steps, which can be defined to the computer so it can plan its assistance in each one of them, has gained great prominence. The idea is that if we track a person's decision-making process, we would probably find a definite process by which he achieves decision-making. Once this process is identified we could install into the computer those functions which would assist a person in each step of the process. If the user wishes to skip some steps while making a certain decision, he can use only those functions involved in steps that are relevant.

(2) Tversky's model of Elimination By Aspects EBA [9]
According to this model alternatives consist of certain aspects differing in their relative importance level. The decision-maker determines certain level in each criterion below which the alternative is ruled out. The decision-maker examines all the alternatives according to the most important criterion and rejects all those that did not make the minimum point. In the next stage he will examine only the remaining alternatives, this time according to the second most important criterion, and rule out, again, those that don't stand up to it. This goes on until the end of the process [9].

In this method of decision-making, there is no compensation for "weak criteria" by "strong criteria" of a certain alternative. This means that a certain alternative which is below a minimum according to one criterion, will be ruled out even if it perfectly suits some other criteria. The "SHESHET" system overcomes this difficulty by considering exceptional criteria. The advantage of the EBA model is its relative simplicity, the fact that there is no need for calculations and the way it suits common sense.

## 3. THE "SHESHET" SYSTEM

### 3.1 Description of the system

The system comprises the five following components:

(1) The data base.
(2) The computerized decision support system.
(3) The student placement plan.
(4) The school guidance operation.
(5) The operational student placement.

We shall describe the five components in detail and the way the DSS technology integrates in the school to provide guidance for the high school freshman.

The data necessary for decision-making are available in two files, the school file and the student file. The school file is small and simple: it consists of the names of the programs the school offers (mechanics, electricity, secretarial, automechanics, etc.), the number of classes per program, qualitative dimensions of the classes, and the list of school resources - such as workshops, science labs, computer stations, teachers, budget, etc.

The student file is large and complicated. It is large because it contains the data of the entire student body, and it is complicated because the student data are not standardized and updated.

Both ideological and sociological controversies interfere with psychometric data collection, achievement measurements, personality traits and preferences (which are critical for the guidance process), thus causing the information base necessary for the educational decision-making process to be both insufficient and invalid.

In this study, we have accepted the individual data available in the school "as is", while keeping in mind the resulting limitations.

The decision support system was developed utilizing "Hypercard" and a Macintosh SE/30 computer. The engine driving the system was based on the "Elimination By Aspects" principle derived from Simon [6] and Tversky's [9] decision-making theory.

Our basic analysis of the decision-making process led us to believe that it followed the "semi structured" model. The relevant individual data (1a) (See Figure 1) are sent as an update into the

DSS (2). The elimination criteria predetermined by the educational staff (such as upper and lower limits of school grades, psychometric profiles, preferences, etc.) are used as rules that support the placement of each individual in a specific class and program.

At the end of the program's decision-making, the system generates an output (3) that consists of several alternatives, $P_1$, $P_2$, ...$P_n$ for consideration of the staff (4). The decision-making now is entirely in the hands of educational team which examines the nature of the different programs, the kind of students that have entered each learning group and the degree of strain that each alternative has put on the school. Individual aspects are also considered: individuals who request changes can apply and justify, and changes of individual schedules can be examined through several alternatives.

At the end, the guidance process is completed by a final decision or alternative Px (5). Upon decision, the individual students and their parents are informed about the decisions concerning their studies while the criteria for the decision are clearly defined and can be justified.

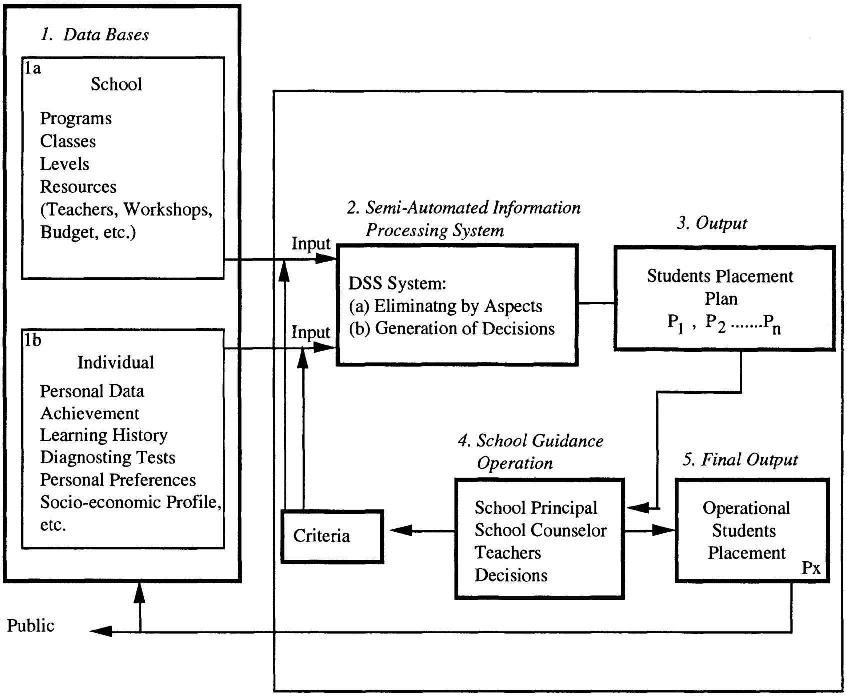

Figure 1. The "SHESHET" Decision Support System

### 3.2 Description of the system

The prototype of the system was developed and tried out in a technological school in Israel during the academic year 1989/90. The school is of medium size - 28 classes, including 700 students.

### I. System adjustment stage

The prototype of the decision support system for guidance and placement of students was adjusted to the demands of decision-making personnel in the school (principal, counselors).

The data base of the system was determined in cooperation with the school counselors with reference to:

1) Structure of the student's card.
2) The files within the student's card.
3) The nature of the different files (number, words, group, record).

## II. Data collection stage

In this stage all the data concerning the students was collected and keyed into the computer. The data included:

1) Personal details.
2) Previous achievements record.
3) Entrance (classification) exams arranged by the school.
4) Students' preference for different vocational programs.

## III. Decision-making stage

The process of decision-making can be divided into three:

1) Guidance according to students' capabilities.
2) Guidance according to opportunities offered by the school.
3) Guidance according to limitations of the school.

Each one of these stages is supported by a relevant part of the software.

## IV. Dialogue stage

The decision-making team chose the first criterion according to which it wanted to start classifying by elimination for the highest standard in the school.

On the basis of the distribution, the team decided the range of the criterion.

The system reviewed data on all students, and a numbered list of those who fulfilled the criteria was produced.

At this stage the decision-makers could choose between four possibilities:

1) Changing the range of the first criterion.
2) Canceling the first criterion and classifying students according to a different one.
3) Checking the distribution of students according to the first criterion against any other criterion.
4) Accepting the first criterion and its range which had hitherto led to a temporary status, and turning them into permanent ones.

Continuation of the placement process depended on the decision made in the first stage.

The decision makers chose another preferable criterion and repeated the whole process as mentioned above. After some alternatives were examined, the decision-makers decided that the group formed according to the criteria they presented suited the course they wanted to determine.

They determined the course (level) and placed the students in vocational programs according to their preferences.

At the end of the classification to the highest standard, an examination was arranged by classifying according to different criteria in order to reach students who could not fulfill the first or second criteria but fulfilled the others.

In the next stage a classification to a lower standard was carried out in which the above mentioned process was repeated.

The student population was similarly placed in courses of study and programs.

## 3.3 Initial evaluation of the system

The prototype of the system has improved and the system worked in an organized manner in the years 1991-92 and 1992/93. The fndings of the research concerning the effect of the system will be published in a paper to follow. The initial evaluation indicated an efficient and effective integration of the system in the school. The system enables handling and processing of a great amount of data, and the placement and classification process now takes hours whereas without the system it took weeks.

The system enables the altering of criteria and the comparison between alternatives, and brings about standardization and objective decisions justifiable.

The system facilitates new options in the midst of the decision-making process: receiving divisions of the classes we built; identification of special groups of students for special treatment and learning; division of the students into groups according to their learning ability in certain subjects, for example, English or mathematics.

The initial findings indicate that the drop-out number of students has been reduced, the transference from one learning level to another has become lower and that there has been an improvement in the achievement of the students.

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# 21

## Geographic Information and School Facility Planning

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Abstract

Recent advances in microprocessor technology have made it possible to find mathematically optimal solutions for school facility planning. Beginning with accurate forecasts based on historical data (such as those available through gradient search, cohort survival methodologies), and supplemented by future-oriented methodologies (such as traditional land use studies), it is possible to gauge expected future growth in a school system and to allocate that growth to specific regions. By disaggregating growth to the building attendance-area level and comparing that disaggregation to building capacities, the out-of-capacity (OOC) status for each building for each future year can be determined. By color coding the OOC status for each building for any one year, a computer generated map can be used to examine geographic relationships of OOC problems.

Here the most significant recent advance in technology comes to bear upon the problem -- finding the optimal location for capital projects (new construction, expansion, replacement, or closing). Using a nonlinear discrete optimizer (such as GAMS 2.25, driving MINOS 5 *) the geographic coordinates of new schools can be identified, and the selection of existing schools for capital projects can be specified, such that transportation is minimized and all other mathematically specified school board policies are honored (racial balance, overcrowding, etc.). Finally, simple binary programming can be used to fix the attendance boundaries for all new and existing schools, assuming that student locations or addresses have previously been geocoded.

Keyword Codes: G.2.m; I.3.8; J.1
Keywords: Discrete Mathematics Miscellaneous; Computer Graphics Applications; Computer Applications Administrative

### 1. INTRODUCTION

New schools are normally built as existing schools become crowded or obsolete. Thus, the optimal location for a new school must take into account the location and capacity of existing schools, the location of students, and which students will attend which schools after the new school is built. Mathematically, this is a considerably more complex question than simply deciding where to build a new school for the purpose of serving a predetermined population.

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* General Algebraic Modeling System (Software), GAMS Development Corp., Washington, DC

If the population of students who will attend a new school is already known, then the X and Y coordinates for the most central location for the new school is simply the average of the X coordinates of the students and the Y coordinates of the students. However, when the new school (or several new schools) is going to supplement an existing set of schools and the attendance boundaries for all the affected schools will be redrawn, then a more general model is useful.

## 2. LITERATURE

A review of the literature reveals that only a small amount of direction or assistance to school administrators is available on site selection. In general, the literature divides itself into two categories. One category provides processes for developing lists of considerations which should affect site selection. For example, see references (1) and (2). In this approach, a team process is advocated in which planners, architects, engineers, real estate and educational personnel take active roles in evaluating a site. By using information which is already in the public domain, such as topographical maps and soil analyses, an assessment of a potential site can be made in terms of the criteria adopted by the team. Such site criteria might include: the fit of the educational program to the site, convenience, physical shape and characteristics, aesthetics, safety, air quality, soils , availability of water and sewer, environmental hazards, relation of the site to highways, zoning, utility service and police, fire and medical coverage.

The team approach is not contradicted by the method which is described later in this paper. Rather, the two could be profitably used together. Once a mathematically optimal location is known, then the team and list approach could be used to adjust the solution for other technical, social and political criteria.

A second category of literature pertains to quantitative methods for suggesting new school locations. For example, McGuffey (3) provides a model for finding a useful starting point in site selection. Although this model does not claim mathematical optimization, it does illustrate one way of integrating enrollment data from existing school populations with distances to potential new school sites.

A more complex microcomputer model has been described by Tanner & Holmes (4). Their model is a derivation of the breaking point model, which uses forecast pupil populations and distances to plot site solutions. A refinement of the Oak Ridge National Laboratories method, referred to as the Modified Land Use Screening Procedure for Sating, allows planners to determine a list of acceptable location criteria and student enrollment forecasts to be weighted and used to solve for site locations.

It was not until the later 1980s, however, that microcomputers were powerful enough to provide truly optimal solutions for site locations. In this context, "optimal" means that some criterion is maximized of minimized (such as transportation distance) while any number of constraints are simultaneously met. Those constraints can involve, for example, policies on school size, racial balance, overcrowding, and underutilization.

## 3. MATHEMATICAL MODEL

It is assumed that the school system using this model will have a file of digitized locations for all students, perhaps as a result of using some sort of transportation and/or student management system. Further, it is assumed that the system has divided the total geographic area it serves into smaller planning regions. The distance from the population center of each region (R) to the existing school (E) may be measured over-the-road, or may be estimated using either a Euclidean ("as the bird flies") or rectilinear (all measurements are horizontal or vertical) calculation. The over-the-road calculation is tedious and error prone unless the system owns some sort of mapping program which supports stand-alone distance calculations, while the Euclidean distance systematically understates the actual distance. The rectilinear calculation for the distance from each epicenter to the existing school ($D_R$) is preferred if over-the-road calculations are not readily available. The rectilinear distance is given by:

$$D_R = |X_R - X_E| + |Y_R - Y_E| \qquad [1]$$

where $X_E$ and $Y_E$ are the coordinates of the existing school, and $X_R$ and $Y_R$ are the coordinates of the population center of each region.

A similar formula applies to the calculation of distances from each region to the new school ($Q_R$).

$$Q_R = |X_R - X_N| + |Y_R - Y_N| \qquad [2]$$

Two decision variables are introduced: $O_R$ and $N_R$. The values of $O_R$ indicate the proportion of students from each R who should attend the existing school. Generally, students will be assigned to schools by region and the values of $O_R$ will be either 0 or 1. The same meanings apply to $N_R$, the decision variable for the new school. Of course, for every R, $O_R + N_R$ must equal 1, since all the students in each region must be assigned to one school or the other. Further, $O_R + N_R$ must be declared as positive variables, since negative values would be nonsensical.

The objective function (Z) is to minimize the total distance traveled by students. That function is given by

$$\text{MIN} \quad Z = \sum_R O_R D_R S_R + \sum_R N_R Q_R S_R \qquad [3]$$

where $S_R$ is the number of students in region R.

The first set of constraints assigns students to one and only one school:

$$\text{For every R:} \quad O_R + N_R = 1 \qquad [4]$$

The next two constraints make certain that the existing school is not overcrowded or underutilized. Overcrowding is defined as having more students assigned to the school than its design capacity (C), and underutilization is defined as having fewer students assigned to the school than 75% of its design capacity.

$$\sum_R S_R O_R \le C \qquad \sum_R S_R O_R \ge .75C \qquad [5]$$

The above two constraints could be removed from the model for the purpose of testing the optimal size of the existing school. This might be done, for example, if an addition were being contemplated as well as a new school. Additional constraints could be included to require racial balance, or to meet any other social or technical goal. Further, adding new variables for existing and new schools, any number of either could be accommodated by the model.

## 4. FORMULATION

The model described above is discontinuous, due to the absolute value operations in the distance equations, and is nonlinear, since there are endogenous variables in the objective function. Thus, a fairly "high powered" modeling and optimization package is needed to model the problem elegantly and to solve it efficiently. The use of GAMS, A General Algebraic Modeling System (5), is demonstrated here, but other packages could have been just as easily used. In the example which follows, twenty regions, one existing school, and one new school, are assumed.

A single set, R, is declared and defined. It has a range from 1 to the total number of regions. In the illustration which follows, R = 1, 2, 3, . . . 20.

Three scalars are declared and defined. The first is C, the capacity of the existing school. The second and third are $X_E$ and $Y_E$, the X and Y coordinates of the existing school.

Three parameters, each with R values, are declared and defined. The first is the number of students in each region, $S_R$. The second and third are the X and Y coordinates of the population centers of each region, $X_R$ and $Y_R$.

Four indexed variables are declared, each over the range of R. $O_R$ and $N_R$ are the decision variables that indicate the proportion of students in region R who will attend either the existing school, O, or the new school, N. O and N are also defined as positive. The other two indexed variables are $D_R$ and $Q_R$, the distance from the population center of each region to the old and new schools, respectively.

Three non indexed variables are declared. $X_N$ and $Y_N$ are the unknown X and Y coordinates of the new school. Z is the value of the objective function which is to be minimized. Z equals the total distance from the population center of each region to whichever school(s) is assigned to each region.

Six equations are declared and defined.

1) The first equation computes the distance from the population center of each region to the existing school. See equation [1] above.

2) The second equation determines the manner in which the distance from the population center of each region to the new school must be computed. Because the location of the new school is determined by the optimal solution, and because the optimal solution is dependent upon the distance calculation which is, in turn, dependent upon the location of the new school, the entire model is nonlinear. See equation [2] above.

3) The objective of the model is given as in equation [3] above.

4) The remaining equations are constraints. One of these equations is indexed over the range of R and makes certain that each region is fully assigned to one school or the other, or to both schools. See equation [4] above.

5,6) The remaining equations prevent overcrowding and underutilization. See equations [5] above.

The GAMS model concludes with the naming of the model and the command to solve the model, minimizing Z, using Discrete Nonlinear Programming. The nonlinear optimizer used here was MINOS 5. The model can be expanded to include as many existing schools and as many new schools as needed. The author has located two new schools simultaneously within a cluster of fifteen existing schools with over 150 population regions under consideration by simply adding corresponding variables to the above model and expanding each equation to refer to all necessary variables.

Table 1
X and Y Coordinates for the Population Center of each Region
X and Y Coordinates of the Existing School

| Region | X | Y |
|---|---|---|
| 1 | 0.59 | 6.82 |
| 2 | 3.00 | 7.01 |
| 3 | 5.18 | 5.58 |
| 4 | 8.21 | 6.82 |
| 5 | 0.81 | 4.62 |
| 6 | 2.19 | 5.42 |
| 7 | 4.40 | 5.20 |
| 8 | 5.61 | 4.81 |
| 9 | 8.41 | 5.22 |
| 10 | 9.81 | 5.00 |
| 11 | 0.78 | 2.20 |
| 12 | 3.39 | 2.61 |
| 13 | 5.18 | 4.01 |
| 14 | 6.00 | 3.82 |
| 15 | 7.59 | 1.81 |
| 16 | 8.21 | 1.81 |
| 17 | 1.79 | 0.82 |
| 18 | 5.16 | 0.82 |
| 19 | 7.99 | 0.41 |
| 20 | 9.58 | 1.40 |
| **School** | **3.39** | **4.62** |

5. EXAMPLE (20 regions, 1 existing school, 1 new school)

Chart 1 is a map of the twenty regions, scaled in miles. The regions are numbered E1 E2, E3, ... E20. The population centers are shown by small circles. The number of students of the age pertinent to the new school) in each region is also shown. The location of the existing school in region E7 is marked. The twenty regions include 1899 students. The existing school has a design capacity of 1025, but its current enrollment is nearly 1200. A second school, presently housing 700 students, is scheduled to be torn down and will be replaced by the new school. The question is, "Where should the new school be built and how many students should be assigned to it, such that the total transportation distance required of all students is minimized and neither building is overcrowded or underutilized?"

The X and Y coordinates of each region and the existing school are given in Table 1.

## 6. SOLUTION

The solution includes the assignment of each region to one or both schools, the distance to be traveled by students in each region, and the total distance traveled by all students. Most importantly, the solution indicates the coordinates of the new school: X = 6.000, Y = 4.010. The objective function was evaluated at 5,474, which represents the total of all student/miles traveled per half-day (i.e., in one set of trips). Most of the solution is presented in Table 2.

Of course, in practice, it would be unusual to be able to build the school exactly where indicated. Thus, Chart 2 shows the optimal location in the middle of a set of concentric rings. Theoretically, the areas in the inner rings represent a better set of solutions than those in the outer rings, but the availability of land, major highways, suitable sites, and so on will dictate what is truly optimal.

Table 2
Assignment of Regions to Schools and Corresponding Distances
Optimal Location of New School

| Region | Portion to Existing (Number of Students) | Portion to New | Distance * |
|---|---|---|---|
| 1 | 1.00 (116) | | 5.00 |
| 2 | 1.00 (097) | | 2.78 |
| 3 | 0.47 (062) | 0.53 (070) | 2.57 ** |
| 4 | | 1.00 (084) | 5.02 |
| 5 | 1.00 (076) | | 2.58 |
| 6 | 1.00 (100) | | 2.00 |
| 7 | 1.00 (127) | | 1.59 |
| 8 | | 1.00 (142) | 1.19 |
| 9 | | 1.00 (068) | 3.62 |
| 10 | | 1.00 (076) | 4.80 |
| 11 | 1.00 (049) | | 5.03 |
| 12 | 1.00 (104) | | 2.01 |
| 13 | | 1.00 (182) | 0.82 |
| 14 | | 1.00 (156) | 0.19 |
| 15 | | 1.00 (097) | 3.79 |
| 16 | | 1.00 (083) | 4.10 |
| 17 | 1.00 (038) | | 5.40 |
| 18 | | 1.00 (053) | 4.03 |
| 19 | | 1.00 (060) | 5.59 |
| 20 | | 1.00 (059) | 6.19 |
| **Total** | **769** | **1130** | |

Optimal location of New School: X = 6.000 Y = 4.010

* Distance is from population center of each region to whichever school is assigned to that region.

** Value is based on weighted distances from this region to two schools

Chart 1. Regions, Existing School Population Centers, and Numbers of Students

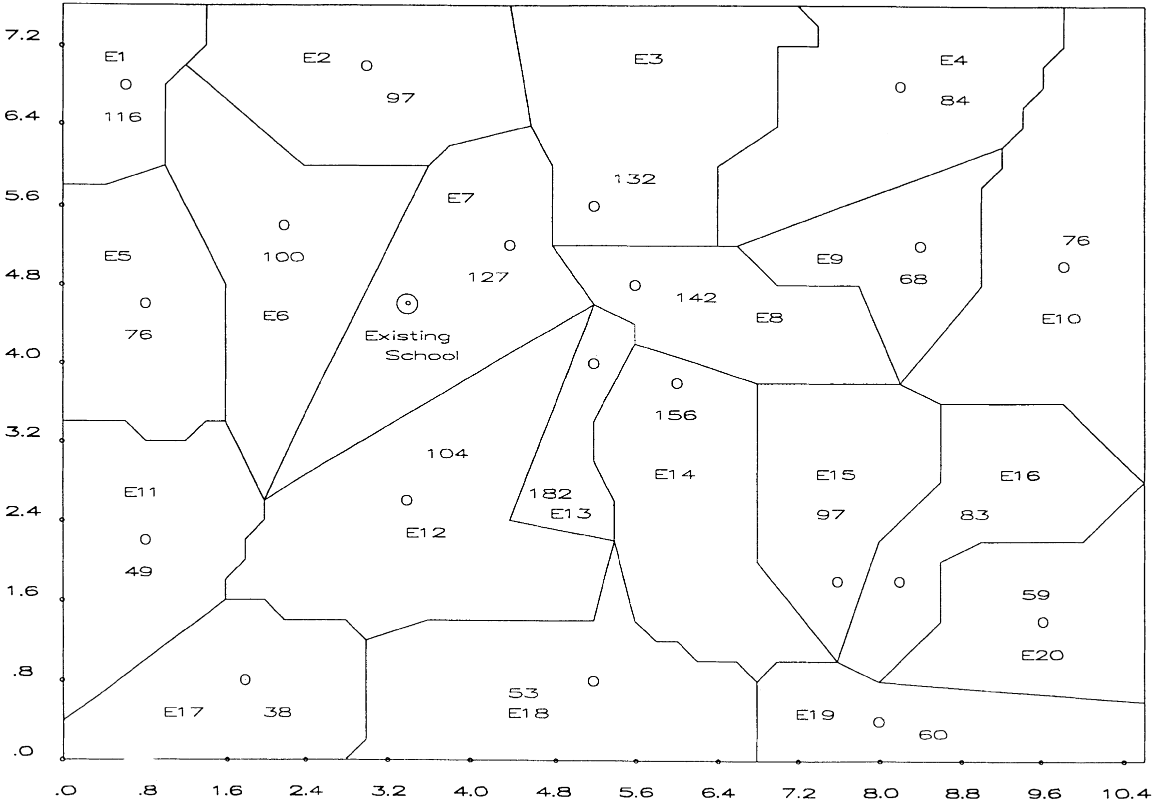
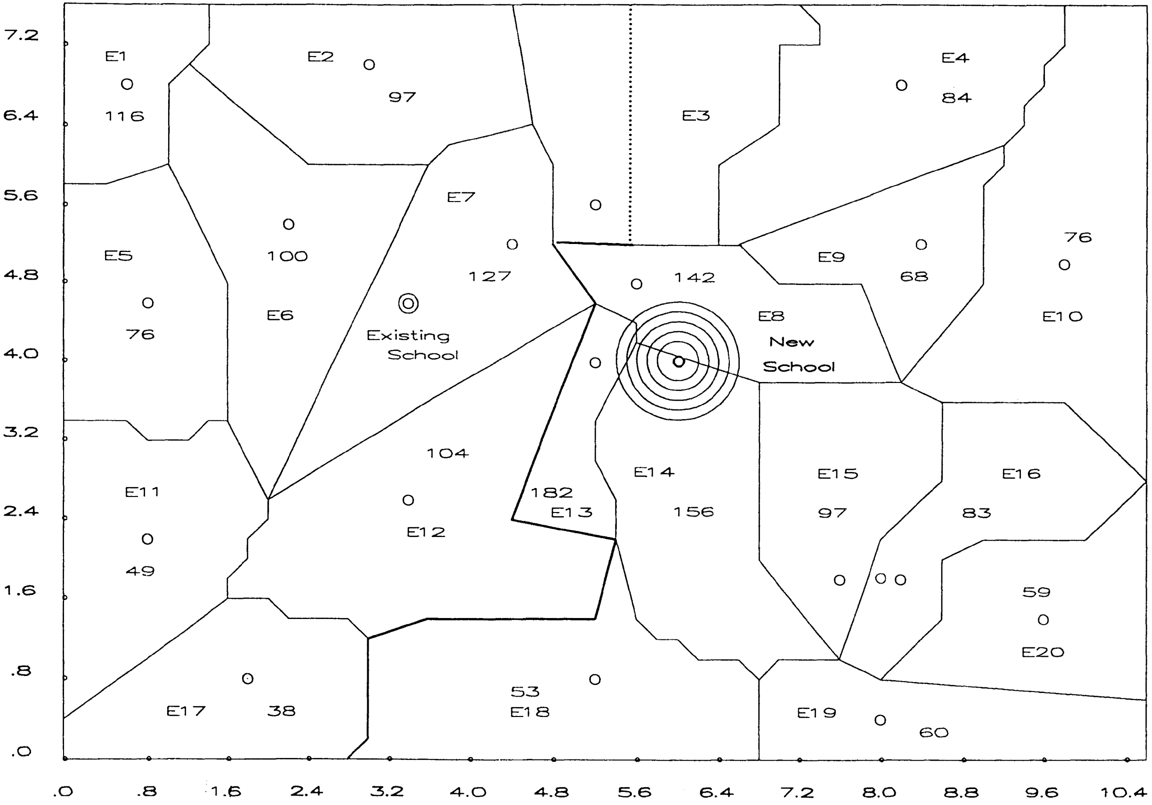


Chart 2. Solution

New School X = 6.000 Y = 4.010



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# 22

# Interactive simulation for planning, coordination and control: Mathematical decision support systems in education

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Complexities in educational management, inherent in the strategic planning of multiple alternatives as well as the tactical control of limited resources, encourage a continued restructuring and export of industrial engineering methods for the educational domain. Such engineering methods, defined broadly as operations research or mathematical modeling techniques, provide a valuable diversity of technical approaches to organizing, analyzing, and interpreting the vast amounts of data stored in electronic management information systems. Given the availability of technology in the forms of high-speed personal computers and low-cost decision modeling software, competing alternative decisions may readily be simulated in order to measure each alternative's impact upon the operating policy in an educational governance system.

Keyword Codes: H.2.8; I.6.7; K.3.1
Keywords: Database Applications; Simulation Support Systems; Computer Uses in Education

## 1. INTRODUCTION

The management of educational practice and process is an inherently complex and complicated task in today's post-modern societies. From problem identification to solution validation, an increasingly scientific approach to problem solving in today's educational sector is necessary to satisfy constituency demands, that the wide range of available data be incorporated into each decision. The wide spread development of management information systems which *plan*, *coordinate*, and *control* daily educational practice and process offers to the educational manager an opportunity to incorporate available data into tactical and strategic decision making.

### 1.1. Decision support systems

When the available data in an organized management information system is used in a systematic way to assist decision making, that management information system may be referred to as a *decision support system*. Basic management information systems collect routine data which can be used to monitor operations, and thereby suggest to the manager, when operations deviate from acceptable practice, that some modification to typical practice (decision) is necessary. It is the manager's interpretation of the deviation recorded by the management information system which suggests to the manager a solution (decision) to reverse the effects of a problem (deviation). A decision support system is an extension of the management information system, in that the data collected by a decision support system not only alert managers to deviations from acceptable practice, but in addition, construct feasible alternative solutions which the manager may reflect upon before making a final decision (choice from among these feasible alternative solutions).

### 1.2. Mathematical modeling

In order to construct feasible alternative solutions, the decision support system reconstructs the "problem setting" as an interrelationship between data in the management information system portion of the decision support system and the collectively exhaustive components of competing alternative solutions. The interrelationship between data and solutions, usually expressed *mathematically* in the form of a cross-reference matrix, constructs a *model* which can trace the *interaction* between data representing the problem and data defining the solution. This interaction provides the basis for a decision support system to compare alternative solutions for their strengths and limitations in meeting the needs of an identified problem. "Best" solutions (*viz.*, optimal solutions) are then suggested to the manager by the decision support system. Suggested solutions are based upon each competing solution's effectiveness in meeting pre-established guidelines or criteria. By *simulating* the consequences of each potential solution, given this competitive interaction between (among) data-based alternatives, the degree of each alternative's effectiveness as a solution may be measured.

### 1.3. Interactive simulation

Interactive simulation, the ability to test the suitability of alternative solutions given what is known about the problem setting, is a formidable component of a mathematical model constructed in the decision support system. As conditions change, the data measured by the management information system portion of the decision support system also change, and the influence of each alternative solution profiled by such data likewise changes.

## 2. MODELS FOR EDUCATIONAL MANAGEMENT

This paper explores, and gives examples of, mathematically formulated, interactive simulation models which can be constructed as part of a decision support system for educational management. These interactive simulation models identify a class of problems in which a probable solution is defined as a finite, mutually exclusive group of "subsolutions" (or partial solutions) which comprise collectively the optimal solution to a problem. Three approaches to subsolution modeling are examined in this paper: *periodic probability transitions*, *hierarchical linear clusters*, and *precedent activity mapping*.

### 2.1. Periodic probabilistic transition model

The periodic probabilistic transition model structures the problem setting as predictable stage-to-stage transformations of objects within a standardized time period. These prediction models provide on-demand the ability to assess the effectiveness of on-going programs which have random-access entry phases of subject (object) entry. Examples of problems in which probabilistic transition modeling has promoted utilitarian solutions follow.

- Determine the predictable impact of a multi-faceted behavioral discipline program on subsequent behavior and categorical recidivism rates.
- Determine the predictable expectancy of course registrations for the development of multi-year course offering schedules based upon demand precedence history.

- Determine the predictable balloting habits of school board members in upcoming policy referenda based upon past consensus decisions by issue of consensual question.

### 2.1.1. Technique

A square matrix is constructed wherein rows represent the 'from-states' which subjects (objects) depart, and columns the 'to-states' which subjects enter. Matrix cells contain the conditional probabilities of these "from-to" periodic transitions. Therefore, each row must sum to 1.0, since all transition possibilities must be accounted for. If any transition places a subject into a state from which the subject can not depart to any of the other states (absorbed), the model is complicated and requires additional interpretation as compared to a non-absorbing model. The initial matrix contains observed conditional probabilities which represent the historical transitions between state 1 and state 2, thus comprising period 1. Next, the matrix is raised exponentially to a power which represents the targeted period under study. For example, if the effect of the 1st transition is of interest, the matrix is raised to the power of 2 (squared), and the resulting cell values are interpreted as expected conditional probabilities for each transition between states in period 2. That is, raising the matrix through matrix multiplication to a power of $\{x\}$ results in the calculation of conditional probabilities expected to exist as a result of period $\{x\}$. Repeated exponentiation of the initial conditional probability matrix will eventually result in a matrix wherein the values of a particular column (to-state) will be identical. When this occurs, the model is said to have reached *equilibrium*, or be in its *steady state*. The value of the exponent required to achieve model equilibrium, and the values of the steady-state probabilities which result, are significant for interpreting the underlying concept (construct) modeled by the periodic probabilistic transition model. Simulation is achieved by altering the conditional probabilities associated with the initial transition matrix based upon suggested changes in policy; or, alternatively, by adding new transition states to the model in order to evaluate potential impact. Decision support status is achieved when the steady-state values satisfy existing policy, or these same values are compared with the equilibrium of a competing periodic probabilistic transition model in order to determine optimal period probabilities.

### 2.1.2. Example

A vocational trades school which serves a large urban school district as a specialty (magnet) school -- enrolling only high school students who have been referred from other high schools because of continuing behavior problems -- has for one academic 10-week term piloted a highly structured, behavioral modification program in terms of graduated levels of punishment based upon repeated or severity of the cited offense. This discipline program has five levels, ranging from a verbal reprimand to expulsion. Students who are expelled are required to re-enroll the subsequent semester. Students who are not presently under any disciplinary censure are considered in-good-standing. A student's disciplinary rating is assessed as the highest disciplinary action adjudicated during the 10-week period. At the conclusion of this 10-week pilot, conditional probabilities were computed, and entered into a periodic probabilistic transition model as shown in *Figure 1*.

At a power of 10 the model illustrated in *Figure 1* reached equilibrium. Therefore, all things remaining equal, the conditional probabilities computed from the 10-week program pilot suggest that, by the conclusion of the 10th 10-week use of this graduated behavior discipline program, the steady-state probabilities for each state in this discipline program may be expected as those values displayed in *Figure 2*.

*Figure 1. Conditional probabilities for student transitions resulting from 10-week pilot.*

| *Discipline Program Options* | IGS | VER | DET | STS | LTS | EXP | RET |
|---|---|---|---|---|---|---|---|
| IGS IN-GOOD-STANDING | .36 | .25 | .05 | .10 | .15 | .09 | -- |
| VER VERBAL REPRIMAND | .44 | .15 | .10 | .20 | .07 | .04 | -- |
| DET DETENTION | .50 | .10 | .05 | .05 | .15 | .15 | -- |
| STS SHORT-TERM SUSPENSION | .65 | .05 | .05 | .01 | .20 | .04 | -- |
| LTS LONG-TERM SUSPENSION | .15 | .25 | .15 | .05 | .10 | .30 | -- |
| EXP EXPULSION | -- | -- | -- | -- | -- | -- | 1.0 |
| RET REINSTATEMENT | .7 | .05 | .05 | .05 | .05 | .10 | -- |

◆

*Figure 2. Steady-state values for student transition probabilities from 10-week pilot.*

| *Discipline Program Options* | IGS | VER | DET | STS | LTS | EXP | RET |
|---|---|---|---|---|---|---|---|
| EQUILIBRIUM | .38 | .16 | .06 | .09 | .11 | .10 | .10 |

Therefore, once model equilibrium is achieved, 38% of all enrolled students can be expected to be in-good-standing during any given period, while 16% of all enrolled students can be expected to have received a verbal reprimand as their highest level of disciplinary censure during any given period. These steady-state values can be utilized for benchmarking purposes. Should any changes to the entry-exit criteria occur, which define each of the graduated disciplinary censure states, recomputation of the model will produce a revised set of steady-state values for comparison with the pilot (benchmark) values.

### 2.2. Hierarchical linear cluster model

The hierarchical linear cluster model structures the problem setting as groups (clusters) of competing (hierarchical) elements. Hierarchical clusters provide an ability to evaluate the best-mix of potential decision (solution) alternatives which (a) satisfy the valued constraints in a given decisioning situation, and (b) optimize (maximize or minimize) some particularly important dependent (positive or negative) objective. Examples of problems in which hierarchical modeling has promoted utilitarian solutions follow.

- Determine which funded components in each program budget (hierarchical cluster) should be increased or decreased, and by how much, given strategic education mission documented needs, and overall available resources.
- Determine which geocoded residential addresses of students should be assigned to which school campus, given an enrollment catchment plan (hierarchical cluster) which must balance enrollments with building capacity, minimize student transportation time, and satisfy affirmative action requirements associated with the socio-economic status and ethnic diversity of student families.
- Determine the best hardware and software combinations (hierarchical cluster) to support computer-assisted instruction, given desired student learning activities by instructional objective across interdisciplinary curricula.

### 2.2.1. Technique

A system of simultaneous linear equations defines a tableau with a rectangular constraint matrix including appended bounded limits (column vector), and an objective function (row vector) to optimize the evaluation of feasible alternative solutions. The multiple equalities and inequalities (rows) in the constraint matrix provide the basis for modeling the criteria for decision making as defined by policy. Bounded limits for each equation or inequality specify the goals of the particular policy modeled. Coefficients in the constraint matrix supply the competitive values of various decision options for modeling as defined by the policy constraints. The constraint matrix identifies which combinations of alternative decisions are feasible (operational) within policy limitations; then, the objective function (vector) selects the "best" alternative by maximizing (minimizing) some *a priori* identified positive (negative) variable according to the stated mission of the hierarchical linear cluster model. Decision variables are dependent variables, and serve to identify the various options (alternatives) which are available to be incorporated into the final solution, and will be assigned a value of either {1} or {0} as a result of model calculations. {1} means that this option will be included as part of the final solution; {0} that the option not be a part of the final solution. A second class of dependent variables, accumulator variables, serve to store total benefits and limitations of the various 'mix' of decision options for re-input to the management information system for reporting purposes. Simulation is achieved by altering the bounded limits associated with the constraint matrix, based upon exploratory discussions of the human decision making; or alternatively, by adding new options for considering in the mix of already available options. Decision support system status is achieved when the model outputs the specific components of an optimal solution.

### 2.2.2. Example

A state education budget oversight committee is charged with the responsibility for suggesting budgetary revisions to present state contributions to local education agency budgets. As a pilot, two LEAs with significantly contrasting budgetary elements have been identified to test the use of a hierarchical linear cluster approach to solution development. The solution, in this case, is to identify what reallocations should be recommended relative to each of these two operating budgets. A partial model is presented in *Figure 3* for purposes of illustration.

This illustration depicts the two program budgets [1.1] with their respective options for budgetary revision [1.2]. The accumulator variables {ΣX, ΣY, ΣZ} on [1.1] specify re-entry to the issuing management information system. One and only one budgetary option can be selected for each budget [2.1-2.2], and the amount of planned budgetary expenditures must not exceed total monies available [3.1]. The extent to which a mix of feasible alternatives' compliance with stated policy goals is returned to the management information system for reporting purposes [4.1-4.3], depends upon the determination of the appropriateness of each mix of feasible alternatives as a probable solution [5.1-5.3]. The final selection of the optimal budgetary solution, the best mix of alternative budgetary options, is made by maximizing (minimizing) the total value of a particular variable [6.1].

## 2.3. Precedent activity mapping model

The precedent activity mapping model structures the problem setting as an exhaustive collection of tasks which must be accomplished to complete an objective. A solution is defined by that finite number of linked (predecessor-to-successor) activities (tasks) which

*Figure 3. Sample tableau formulation of the hierarchical linear cluster model.*

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.1 | --------- A --------- | | | ----- B ----- | | $\Sigma X$ | $\Sigma Y$ | $\Sigma Z$ | | |
| 1.2 | 1 | 2 | 3 | 1 | 2 | | | | | |
| 2.1 | 1 | 1 | 1 | | | | | | = | 1 |
| 2.2 | | | | 1 | 1 | | | | = | 1 |
| 3.1 | $\$\$_{A1}$ | $\$\$_{A2}$ | $\$\$_{A3}$ | $\$\$_{B1}$ | $\$\$_{B2}$ | | | | ≤ | $\$\$_{TOT}$ |
| 4.1 | $X_{A1}$ | $X_{A2}$ | $X_{A3}$ | $X_{B1}$ | $X_{B2}$ | -1 | | | = | 0 |
| 4.2 | $Y_{A1}$ | $Y_{A2}$ | $Y_{A3}$ | $Y_{B1}$ | $Y_{B2}$ | | -1 | | = | 0 |
| 4.3 | $Z_{A1}$ | $Z_{A2}$ | $Z_{A3}$ | $Z_{B1}$ | $Z_{B2}$ | | | -1 | = | 0 |
| 5.1 | | | | | | 1 | | | ≥ | GOAL X |
| 5.2 | | | | | | | 1 | | ≥ | GOAL Y |
| 5.3 | | | | | | | | 1 | ≥ | GOAL Z |
| 6.1 | $OF_{A1}$ | $OF_{A2}$ | $OF_{A3}$ | $OF_{B1}$ | $OF_{B2}$ | | | | | |

determine the necessary duration (critical path) of a project. These directional linkages between activities are resource-bearing, and provide critical benchmarks which identify potential problems to project completion as each activity is operationalized. Examples of problems wherein precedent activity mapping has promoted utilitarian answers follow.

- Determine critical resource requirements of the critical path in order to define priority for resource availability.
- Determine non-critical resource requirements which might be redistributed to a critical path element, should that element's progress jeopardize the entire project map.
- Determine interrelationships between competing critical paths of multiple projects for strategic planning and global program (multiple projects) coordination and control.

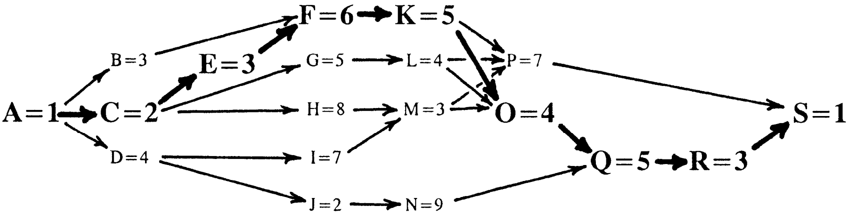
### 2.3.1. Technique

Activities are defined by (a) observable actions required to satisfy the activity as stated, and (b) enumerated resources necessary to fulfill the requirements of each activity's actions. Each activity is designated by a unique numeric (or unique alpha) code, and those activities which immediately precede a subsequent activity identified using that code. This predecessor-successor link provides the basis for constructing an activity-on-node network, wherein resource-bearing nodes denote activities, and connective arcs (unidimensional arrows) denote precedence. Solution of the nodal network is trivial. A retrograde summation approach begins with the end (completion of project) node and proceeds backwards by summing t time components of each node along any interconnected path through the network, and concluding with the start (beginning of project) node. Therefore, each possible sequence of interconnected nodes throughout the network defines a network path. The path with the largest time component sum -- that path which defines the anticipated completion time (duration) of the project, and therefore the path wherein any delay produces a delay in the anticipated completion of the project -- is defined as the critical path, and thus benchmarks the nodal network for monitoring the progress of the project towards completion. Simulation is achieved by reorganizing the nodal precedent linkages to study impact to the system; or, alternatively, by redistributing available resources in order to facilitate the completion of competing resource tasks. Decision support system status is achieved when the relationship between time-to-completion and resource expenditures satisfy the stated mission of the original project.

### 2.3.2. Example

A school district has decided, that a classroom building, mothballed some years ago during a period of severe declining enrollment, should be reconditioned for instructional use during the upcoming academic year because of projected demand due to escalating district enrollments. Due to the complex activities associated with reconditioning a building, and the extensive use of independent subcontracted companies, the district business manager has constructed an activity-on-node network to display graphically the full reconditioning project. *Figure 4* illustrates a small part of this nodal network.

*Figure 4. Activity-on-node network for instructional building reconditioning project.*



The critical path for this precedent activity mapping model is identified by the enlarged, bolded nodes along the critical path as shown in *Figure 4*, and as detailed in *Figure 5*.

The sum of the time components for each activity along this path equals 30 units, and by inspection can be proven to be the longest path through this network. Thus, the time necessary to complete this portion of the reconditioning project is 30 units. Other resources (personnel, equipment, materials, etc.) can be accumulated similar to the time component. An analysis of this network provides important information to the planner, in addition to identifying the critical path elements by activity nodal name. Slack for each activity, the amount of time an activity can be delayed without delaying the entire project's anticipated completion date, is calculated. In addition, actual calendar dates and 2400 clock times can be displayed for each of the elements inherent in slack calculations: earliest and latest start/finish times. Based on this benchmarking by initial critical path, any subsequent change to the network due to shift of resources, delay in activity start or completion, or related unanticipated problems, can be input to the model, and the model re-analyzed for updated benchmarking.

*Figure 5. Detailed listing of nodal elements and critical path.*

```
                                 Earliest    Latest
Activity  Symb          Time    Start/Fin   Start/Fin      Slack

ACT   1    A          1.0000     0.0000      0.0000       0.0000 critical
                                 1.0000      1.0000
ACT   2    B          3.0000     1.0000      3.0000       2.0000
                                 4.0000      6.0000
ACT   3    C          2.0000     1.0000      1.0000       0.0000 critical
                                 3.0000      3.0000
ACT   4    D          4.0000     1.0000      3.0000       2.0000
                                 5.0000      7.0000
ACT   5    E          3.0000     3.0000      3.0000       0.0000 critical
                                 6.0000      6.0000
ACT   6    F          6.0000     6.0000      6.0000       0.0000 critical
                                12.0000     12.0000
ACT   7    G          5.0000     3.0000      8.0000       5.0000
                                 8.0000     13.0000

                      * REMAINDER OF LIST TERMINATED *
```

## 3. SUMMARY

Mathematical decision support systems provide a wide variety of models which will (a) interface easily with data stored routinely by management information systems, (b) provide for simulating alternative solutions to a particular problem for review purposes, and (c) promote effective and efficient coordination and control in strategic planning in education. Linking a model with the existing management information system provides for continuous updating of the linked model, and therefore, continuous updated decisional options to the decision maker. As a result of these model interactions, the management information system can be supplied with new data from the analysis of the alternatives modeled. Perhaps the most significant benefit from the mathematical modeling of alternative decision situations within the context of a decision support system, is that of the decision maker's ability to simulate the impact of alternative solutions upon the problem environment. Simulating the probability of likely occurrences (effect) based upon alternative actions (cause) provides assurance that rational decision making is paralleled by critical thinking.

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# 23

## Computerized Support in Decision-Making Processes in Israeli schools.[1]

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### Abstract

The article describes difficulties arises using information in Decision Making Processes (DMP) . Then analyzes the computerized support in the DMP and describes the Expert System " "MATANA" that supports the learning management processes at school. "MATANA" has been tried in several schools.
The main findings of a follow up study were:

* The use of "MATANA" helped the principal to manage the laerning system, while broadening his cognitive abilities.

* The system created a more objective base for the learning management detached from inter presonal relationship.

Key word codes : I . 2 . 1 ; K . 3 . 1
Key words : Applications and Expert Systems ; Computer uses in education.

## 1. INTRODUCTION

The true test of the teaching quality is in the development and incorporation of learning processes which lead to learning achievements. The conversion of teaching processes into learning processes is accomplished mainly by developing group processes, which generate learning activities in each of their members ,which act as a group of learning units [ 2 ].

This situation necessitates proper *learning management processes* aimed at directing and establishing learning. The processes exist on two levels: learning management by the teacher in the classroom and learning management by the school principal and the subject coordinators on the group level [ 8 ]. In this paper we will focus on the group level.

Organization systems, including schools, are characterized by a high degree of complexity which is directed by decision- making of office holders within the system. The school principal and subject coordinators exert strong influence on the nature of school functioning and its production, and on the nature of teaching-learning processes and learning achievements, by action or by default.

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[1] The study was carried out within the framework of the author's doctoral thesis, under the supervision of Prof. D. Chen.

However various problems within two groups of factors cause difficulties to the school principal in carrying out his job. The first group of factors is conceptual and comprises task perception, aims of learning achievement assessment, etc. The second group includes a list of practical difficulties relating to information use and cognitive difficulties connected with decision-making processes. Both groups of difficulties exist within a closed circuit; the elimination of one of its elements enables a breakthrough. The conceptual element cannot be dealt with so long as the practical element exists. However, a change in the practical-cognitive element has become possible with the potential that information technology now offers. Our paper will focus on the description of the difficulties and the specification of this potential. We will then describe the contribution, both theoretical and actual, of the expert system "MATANA" and its influence on the learning management system in schools [7]

## 2. DIFFCULTIES IN USING INFORMATION LEADING TO DECISION MAKING

Difficulties arising between user and information develop in three "environments" or groups of factors which interact:

* Difficulties connected with the cognitive process.
* Difficulties originating in the nature of decision- making situations.
* Difficulties developing in decision-making processes, which include practical difficulties in dealing with information.

### 2.1 The cognitive process and decision-making

Psychological research has dealt with the nature of the cognitive element which forms the nature of human decision-making [ 1 ]. Limitations of the cognitive process can be caused by a number of factors:

* Selective perception, developing from various conceptual frameworks this is uniquely self-strengthening.
* Limitations of human thought, due to variations in cognitive abilities and connecting to different styles of thinking.
* Motivational tendencies, such as defensiveness which reinforce selective perception on an additional plane.
* Limitations of human memory which hinder development of an interactive process between consciousness and memory.

These and other limitations may result in a person acting in a "perceptual environment" rather than in a real one. The main question is: *whether the "perceptive environment" can be made into a representative sample of the real environment and how this may be done best.*

### 2.2 Difficulties arising from the nature of decision-making situations.

The nature of decisions depends on the nature of the decision-making situations. They exist on different levels on a continuum which stretches from certainty (almost complete) to great uncertainty. Four phases may be observed [ 10 ]:

I Deterministic situations, clearly structured and well defined. Decision-making rules and/or an algorithm of the decision-making process may be determined in advance, leading to "automatic" and clearly structured decisions.

II Probability situations. These situations are not clearly structured, but by acting in accordance with well-known and accepted rules of probability they "become" deterministic and well structured.

III Deterministic and partly structured situations. These situations partly resemble those mentioned under (I) and partly those under (IV) , below.

IV Heuristic decision-making situations not ,clearly structured or defined in any way. These situations produce heuristic decisions based on intelligent guesses which are founded on the wisdom of accumulative experience.

Decisions in organizational systems, decisions relating to the management of a learning system by the principal, for example, usually occur in heuristic decision-making situations with a great degree of uncertainty [1]. Here the principal relies on basic suppositions and projected intelligence designs , which are at times incorporated and uncontrolled. He relies on his intuition without having sufficient information and tools for its analytic substantiation. Finally he creates for himself, by a spiral and interactive process, a partial and biased "perceptual environment".

### 2.3 Difficulties in using information in the decision-making processes.

The decision-making process may be divided into two main elements, descriptive and inferential.

The first includes: data collection and data processing; while the second conssist on information interpretation and decision-making.

Five types of practical difficulties relating to information use arise in this context [ 8 ]:

* Difficulties in *encompassing all the data* in the system.
* Inability to *process* data and prepare a *wide variety of reports* as required.
* Problems relating to the *quality of information* which is determined by the extent of its being up to date, complete, precise, relevante.
* Difficulties in *controlling information*, relating to its selective availability.
* Difficulties in *information analysis and interpretation*.

Routine treatment of the problem by means of computerized information systems like MANBASS[2] (Israel) SIMS (England) etc., [ 7 ] solves the two first types of difficulties completely and provides partial solutions to the third. However, an extended study of principals using MANBASS has indicated increasing difficulties in the control of information as the user is flooded with new information. There are also significant difficulties in analysis and interpretation of information which derive from difficulty in control as well as from the user's partial knowledge in the sphere of methodic pedagogy.

Thus has prompted me to develop an Expert System (ES) support decision-making as it relates to the management of the learning system in the school [ 3 ], [ 4 ]

## 3: "MATANA" AS A LEARNING MANAGEMENT SYSTEM (LMSS).

### 3.1 Broadening cognitive abilities [ 9 ]

Just as the technology of materials and energy can broaden physical man's abilities so the information technology can broaden his cognitive abilities, as mentioned above. Transaction Processing Systems (TPS) help in overcoming the two practical types of difficulties mentioned above as well as part of the third one, but it does not handle other types of problems. In contrast, Expert Systems (ES) treats complex existing problems which require expert interpretation [ 5 ]. These systems comprise, in addition to routine elements of information processing (data base and processing and organization mechanisms), a knowledge base, inference engine and an interactive interface for the user [ 1 ]. Expert systems supporting decision-making processes are in fact a combination of ES and DSS (Decision Support Systems) and are called EDSS.

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[2] "MANBAS" - a Hebrew acronym for a computerized information system , operating within the schools in Israel.

Generally speaking, EDSS brings the decision-making ability of human experts in the field, or on specific subjects, together with their limitations in ability to foresee all anticipated events, and/or their complexity. Experts offer a number of capabilities:

* Thinking at various high cognitive levels.
* Infrastructure of well reasoned and appropriate basic assumptions.
* Comprehensive, profound and specific knowledge of the field.
* Guidance in the use of data and information.
* Suitable decision-making frameworks for use in various situations.

These capabilities, together with the system's ability those of inference, analysis and reasoning constitute the possible contribution to the everyday user in a number of spheres:

3.1.1. : The system puts new and improved cognitive tools and perceptual means at the users disposal and these create an *infrastructure and network of decision-making frameworks*,which allow reliance on *the cognitive modes of the human expert.*

3.1.2. : The system provides the user with *knowledge in specific fields* of expertise thus enabling development of consulting processes with experts. The knowledge presented and the ways in which it may be used *will fill the decision-making frameworks* previously built in a *general context and which will include "a code of behavior" of the various factors involved.*

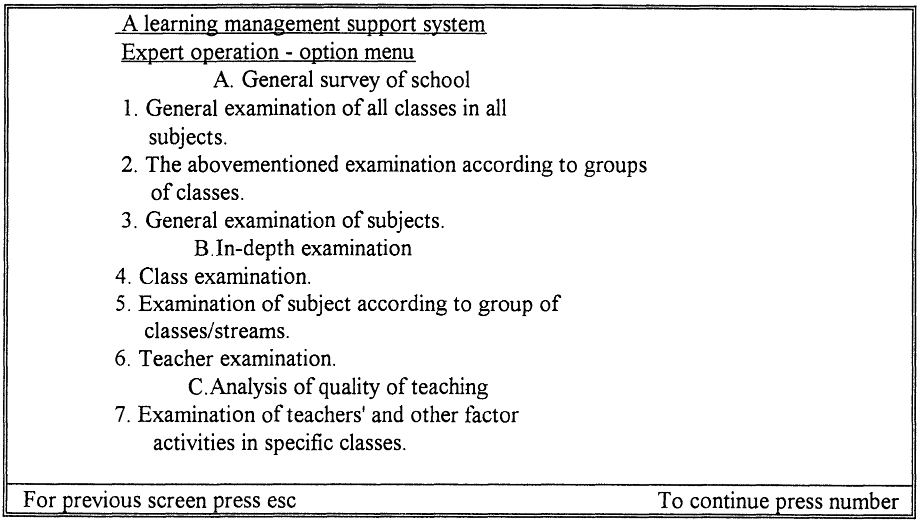
3.1.3: The system will assist in proper use of information by structured separation of the descriptive from the inferential elements. First, *a selective examination of relevant data and selective operation of the processed data for the presentation of information relevant to the situation being researched* will take place. Later, with the assistance of the knowledge base and the inferring mechanism, the system will present an *examination of alternative interpretations of the context revealed with an emphasis on the preferable interpretation of the situation studied.*

In summary, the system supports all the spheres of difficulties described above and which develop in heuristic decision-making situations, for instance a learning management system. Against the background of the "general context" and the infrastructure of decision-making frameworks mentioned above, a context specific to the studied situation emerges thus allowing the formulation of *"a perceptive environment" which is more objective , rational and well-founded.*

The responsibility and superiority of the human factor in this process should be mentioned here. The intelligent user will reflect these by *pedagogical consideration* based on his knowledge which is either intuitive or partially substantiated and which will include nuances known only to him. This "knowledge" will induce a *fertile confrontation* with "a second opinion" that of the expert, [ 6 ].

### 3.2 : "MATANA", a general description

The purpose of the following description is to provide a general presentation of the system[3] The option menu will follow the introductory screen [ 9 ]:



A learning management support system

Expert operation - option menu

A. General survey of school

1. General examination of all classes in all subjects.
2. The abovementioned examination according to groups of classes.
3. General examination of subjects.

B.In-depth examination

4. Class examination.
5. Examination of subject according to group of classes/streams.
6. Teacher examination.

C.Analysis of quality of teaching

7. Examination of teachers' and other factor activities in specific classes.

For previous screen press esc　　To continue press number

The option menu demonstrates the system's three stages:

* In the first stage the system surveys the students' achievements[4] in order to locate irregular learning situations in the school, or in various sectors, as described above.

* In the second stage the system focuses on the sector identified as a location of irregular learning situations, or one that has previously been recognized as such, and conducts in-depth examinations of three possibilities, according to the user's choice.

* The third stage is different from the previous two. Here the system analyzes the teaching situation qualitatively and not quantitatively as before. The user will collect data and enter it into the system as an answer to the computerized questionnaire.

In each of the examinations of the first stages (A,B) the system provides three outputs:

* A summarizing table of failure occurrence in the tested sector, for example, the percent of failure in mathematics at school, according to three levels (as determined in advance by the user) .

* A table specifying failure occurrence in mathematics, according to teachers and classes in one of the group of classes, according to the user's choice.

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[3] A more detailed account may be found in (8) .

[4] The students achievements , in each of the tests were determind by the grades obtained in tests conducted over the year or at the end of the trimester / semester , according to the user's choice.

* Verbal findings that provide a description of the location and characteristics of the problem, and finally the conclusions and recommendations derived from the specific case.

The system examines various characteristics of irregular learning situations. For example: Does the problem arise in one or more classrooms, Is it characteristic of one particular teacher and various students in the class, or does it exist among several teachers with the same students? In addition, a test of various statistical indices is conducted; for example, the nature of grade distribution and average grade. The combination of the examination results contributes to the system's recommendations, based on expert opinion which is built into the system in a series of logical rules,of the form "if...then...".

The third stage (C) analyzes the quality of teaching. It is here that the system examines the *nature of learning program implementation as carried out by specific teachers in a given class*. The groups of factors examined here are:

* learning organization and planning
* teaching and development of learning operation
* the learning environment
* classroom climate and physical factors
* teacher-student relationship
* class management by the teacher

The user examines the teaching performance of a specific teacher several times in different classes, or that of several teachers in a specific class, teaching performanc of several teachers in one specific subject, or in different groups of classes. The system weights the average of the examination results and presents the characteristic findings of teachers, classes and subjects. These serve as a basis for future pedagogical instruction.

### 3.3 Use of "MATANA"and its effects

"MATANA" has been tried out in several schools and a follow-up study of its use in the system has been carried out. Its effect on school principals was tested in comparison with the effect of MANBASS.

Below are some of the findings:

* The principals' opinion is that both control and quality of information are improved when using "MATANA", as a result of the selective availability of required information.
* The principals found that the system adequately supports the analysis of information, as the decisions rely on well-founded and practical information.
* Use of "MATANA" resulted in the transfer to the principal of initiative for system control and in the development of routine examination during the school year.
* Guidance provided by the system directed principals to broaden and diversify decision-making subjects. Along with decisions regarding students, decisions were reached regarding level of teaching, suitability of syllabus, teacher behavior, etc.
* The principals' opinion was that the system creates a more objective basis for the management of the learning system and is independent of interpersonal relationships , leading to "more persuasive" results.
* Teachers in need of guidance were identified and in some cases guidance was provided.

* However, feelings in the teachers room were mixed. Despite the advantages, the teachers felt more threatened than they did after using MANBASS.

To complete the picture we will present the system's two main limitations and give appropriate recommendations:

* The set of rules is limited a priori as a result of the impossibility of foreseeing all irregular situations. In order to overcome this limitation we would recommend to continue the development of the knowledge base, while taking into account the users' remarks and the knowledge gained by cumulative experience.

* There is a danger that the user will be subject to "idleness" vis. a vis the system; this will result in him not using his reasoning powers and there will be no fertile confrontation as described above. Experience proves that appropriate guidance may be helpful in this matter.

Guidance and gradual operation are mandatory for good implemantation and correct operation of "MATANA".

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## PART FIVE

# Specific Applications

# 24

# Information Technology and the Management of Instructional Programs: Meeting the Challenge of Curriculum-Time Compression in Schools

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## Abstract

Presently there exists an important need for employing information technologies to assist educators in the complex task of monitoring and supporting instructional programs. Using technology to enhance a comprehensive low cost and mass scale formative evaluation of student attainment is one mechanism for achieving this elusive goal. Recent global trends toward compressing school curricula to include more advanced academic topics taught at lower levels of instruction (elementary, secondary, college), or teaching the same topics in shorter time periods has served to underscore the need for technology based instructional support. This paper reports the results of recent research with a technology based, formative evaluation procedure called Information Referenced Testing (IRT). With information technologies, not only is one able to better assess individual student attainment, but to simultaneously better assess the quality of the instructional program itself.

Keyword Codes: J.4; H.4.0; K.4.1
Keywords: Computer Applications; Information Systems; Computers and Society; Social and Behavioral Sciences; Applications General; Public Policy Issues

## 1. INTRODUCTION

In the near future, the role of information technologies will expand from one of providing information for resource allocation, budgeting, and accounting, to one of providing information for instructional support to promote student learning.

The availability of networked, low cost microcomputer information *processing* and newly developed information *acquiring* systems will soon merge with sophisticated optical scan technologies to assess, monitor, and prescribe detailed learning plans of action for the individual student, the teacher, and the school administrator.

Educational management in this more comprehensive view of instructional support will be both *individual student centered* as well as *group centered.* An impetus to merge these two technologies (information *processing* with information *acquiring*) has been provided by the enormous amounts of curricula compression that has occurred in schooling over the past two decades. The global phenomenon of curriculum-time compression, where formerly advanced subjects and topics are taught at lower levels of instruction (such as elementary, middle, and high school) and more topics are taught in shorter time periods, will place enormous strains on already overworked instructional support systems in educational organizations. Enhancing the ability to teach more in less time and preparing students for more advanced levels of instruction will, therefore, be important objectives for these technology based instructional support systems.

In order to respond to the curricula-time compression phenomenon, schools, especially elite private schools, are merely selecting students at higher and higher levels of academic attainment. Other schools, mainly suburban public schools, are essentially "dumbing down" instructional programs because students are simply not able to keep up with the rapid pace required to succeed in these compressed curriculums. Some schools, such as inner city schools in large urban areas, have little or no instructional support for their students either from the home or from technology. These schools have simply given up and have placed an entire cohort of students "at risk" in their subsequent education by warehousing their students—especially in the areas of science and mathematics.

In order for schools to effectively respond to the curricula-time compression phenomenon, instructional support has to merge with information acquiring and information processing technologies to provide a more enhanced and comprehensive formative evaluation of the instructional program.

In short, in order to respond to curriculum-time compression, more sophisticated information technologies for educational management (ITEM) schemes have to be developed. These schemes might take the general form of 1) expanding and relying on information technologies to service or "process" the information needed to support instructional programs, 2) shifting emphasis on student assessment from "summative" evaluation to enhanced "formative" evaluation via sophisticated information "acquiring" technologies, and 3) developing the reliability, maintainability, and economic viability of combination information *processing* and *acquiring* technologies.

A principle focus of this paper, is directed at the information *acquisition* technologies or technology based formative evaluation procedures for instructional support and educational management. Specifically, this paper focuses on "information referenced" types of student assessment procedures and how these procedures can be placed into a comprehensive formative evaluation system in an educational setting to support instruction. These types of technology based formative evaluation procedures can then be used to provide specific diagnostic information to the instructional management

TRIAD (student, teacher, administrator) in a format needed to enhance overall educational management.

The centerpiece for this type of formative evaluation technology is 1) the instructional audit of knowledge or information, 2) a scoring system to *acquire* student attainment information that is referenced to an information quality assessment standard, and 3) a technology to *process* this information and place the results into a format that is needed for instructional support and educational management.

In summary, on two levels—the ability to acquire attainment information and the ability to process information—Information Technologies for Educational Management (ITEM) can become an important instrument that can be used as an effective response to the growing phenomenon of curricula-time compression.

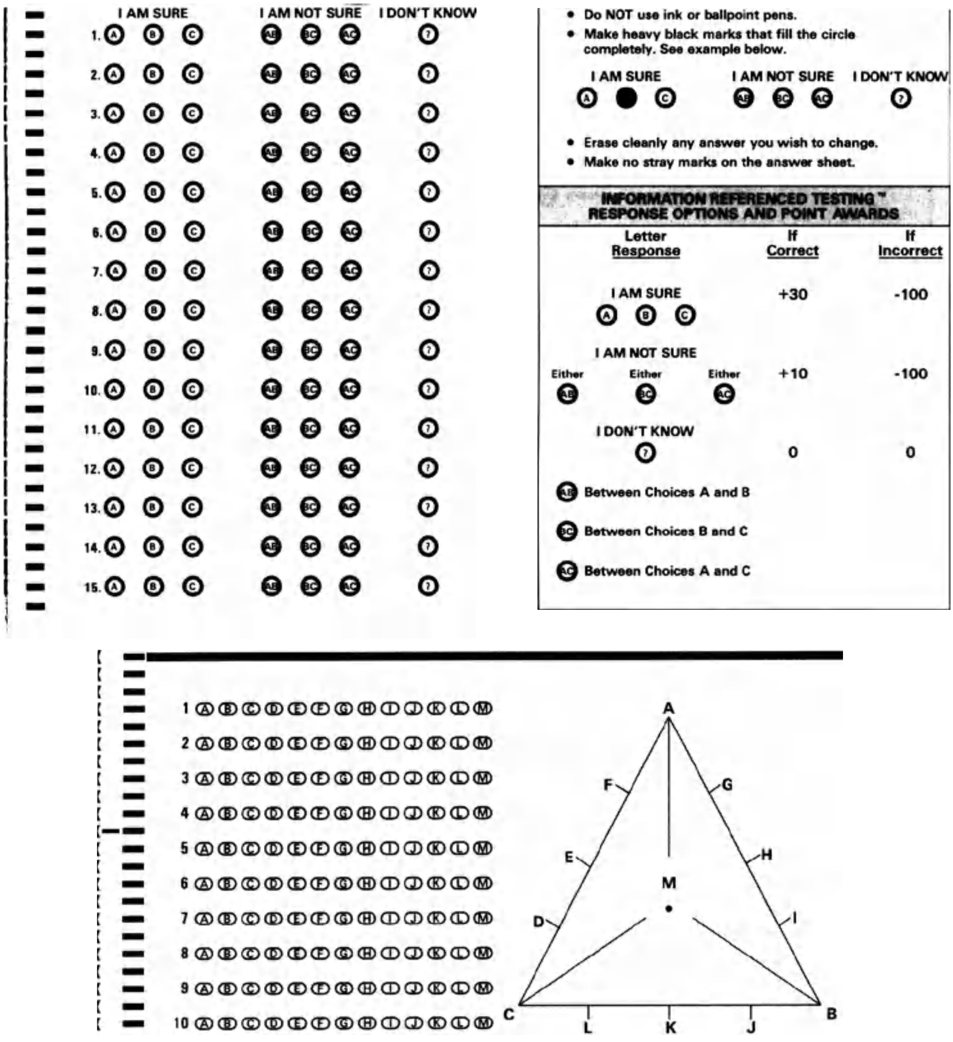
## 2. INFORMATION ACQUIRING TECHNOLOGIES FOR INSTRUCTIONAL SUPPORT

In order to "acquire" attainment information for purposes of enhanced formative evaluation and instructional support, a different type of information acquiring technology is needed. This type of technology has to be able to assess student attainment, not with a *one* dimensional or recognition only (right-wrong, or RW) type of test scoring system, but with a *two* dimensional (recognition plus confidence in that recognition) and information referenced (misinformed, uninformed, partially informed, and informed) type of scoring system. In essence, enhanced formative evaluation requires that the information "quality" of students be assessed.

Extensions of two dimensional types of test scoring systems to make them compatible with modern optical scan technologies and to specifically generate formative evaluation feedback and reports to the instructional management TRIAD have recently been placed into an Information Referenced Testing (IRT) format [Bruno, 1987].

Applications of the IRT procedure to urban inner city student instructional audits [Bruno, 1988] and direct research comparisons between RW and IRT formats [Bruno, 1989] have also appeared in the educational research literature.

IRT research and technology based formative evaluation has also been extended to other important areas in the research of Baxter [1991, 1993], at risk inner city student formative evaluation at large inner city elementary schools and Klentschy [1992], for supporting accelerated learning in classrooms.


I AM SURE
I AM NOT SURE
I DON'T KNOW
1.–15.
Ⓐ Ⓑ Ⓒ
AB BC AC
?
1–10
A B C D E F G H I J K L M
A
B
C
D
E
F
G
H
I
J
K
L
M

- Do NOT use ink or ballpoint pens.
- Make heavy black marks that fill the circle completely. See example below.

I AM SURE Ⓐ ● Ⓒ I AM NOT SURE AB BC AC I DON'T KNOW ?

- Erase cleanly any answer you wish to change.
- Make no stray marks on the answer sheet.

**INFORMATION REFERENCED TESTING™ RESPONSE OPTIONS AND POINT AWARDS**

| Letter Response | If Correct | If Incorrect |
|---|---|---|
| I AM SURE<br>Ⓐ Ⓑ Ⓒ | +30 | -100 |
| I AM NOT SURE<br>Either AB Either BC Either AC | +10 | -100 |
| I DON'T KNOW<br>? | 0 | 0 |

AB Between Choices A and B

BC Between Choices B and C

AC Between Choices A and C

Figure 1. Optical scan answer sheets needed to support technology based formative evaluation

## 3. INFORMATION FOR THE EDUCATIONAL MANAGEMENT TRIAD: THE STUDENT

The Individual Education Plan (IEP) is the actual diagnostic formative evaluation "audit" of the student information base that is needed for instructional support. The audit concept can be used by the teacher (parent, employer) to provide a plan of action to keep the student (employee) "on line" with regard to currently needed levels of reliable information. This IRT report called the IEP, essentially articulates the instructional program to students (and parents) and is used solely for purposes of "student centered" formative evaluation (portions of IEPs can be found in Figure 2a—poor information quality and 2b—good information quality).

```
MISINFORMATION—CONCEPTS WHERE YOU WERE SURE OF AN ANSWER BUT WERE WRONG—HAVE INSTRUCTOR
EXPLAIN WHY THE ANSWER YOU THOUGHT WAS CORRECT WAS WRONG AND WHY ANOTHER ANSWER WAS
CORRECT

TEST ITEM (INF STATE)    DESCRIPTION INSTRUCTIONAL CROSS REFERENCE
        1 M                  TO USE PLACE VALUE CONCEPTS—4 DIGIT NUMBERS
         .                   ADDISON WESSLEY 4TH GRADE CHAPTER 2 P. 26-27
         .                   .
         .                   .

EXAMINEE UNINFORMED (LACKS INFORMATION) RESPONSES

CONCEPTS YOU SAID YOU DIDN'T KNOW—HAVE YOUR INSTRUCTOR EXPLAIN THESE CONCEPTS TO YOU

TEST ITEM (INF STATE)    DESCRIPTION INSTRUCTIONAL CROSS REFERENCE
        2 U                  TO USE PLACE VALUE TO READ UP TO 6 DIGIT NUMBERS
         .                   ADDISON WESSLEY 4TH GRADE CHAPTER 2 P. 26-27
         .                   .
         .                   .

PERCENT INFORMED, 0.33; PERCENT UNINF, 0.37; PERCENT PART INF, 0.27; PERCENT MISINF, 0.03;
PERCENT RIGHT WITH RW, 0.0; PERCENT WRONG WITH RW, 0.0
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPUUUUUUUUUUUUUUMMMMMMMMMMMMMMMMMMMMMMMMMM
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPUUUUUUUUUUUUUUMMMMMMMMMMMMMMMMMMMMMMMMMM
```

Figure 2a. Portion of an IEP of a student with poor information quality (Note high levels of misinformation)

```
EXAMINEE FULLY INFORMED ITEMS ON EXAMINATION

CONCEPTS WHERE YOU WERE SURE OF THE ANSWER AND WERE CORRECT—YOU HAVE RELIABLE
INFORMATION IN THESE AREAS—KEEP UP THE GOOD WORK

TEST ITEM (INF STATE)    DESCRIPTION INSTRUCTIONAL CROSS REFERENCE
        1 I                  ESTIMATE SUMS BY ROUNDING TO NEAREST TEN, HUNDRED
         .                   ADDISON WESSLEY 4TH GRADE CHAPTER 3 P. 56-59
         .                   .
         .                   .

PERCENT INFORMED, 0.87; PERCENT UNINF, 0.10; PERCENT PART INF, 0.0; PERCENT MISINF, 0.03;
PERCENT RIGHT WITH RW, 0.0; PERCENT WRONG WITH RW, 0.0
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIUUUUUUUUUUUUUUUUUUUUMMMMMM
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIUUUUUUUUUUUUUUUUUUUUMMMMMM
```

Figure 2b. Portion of an IEP of a student with good information quality (Note high levels of reliable information)

## 4. INFORMATION FOR THE EDUCATIONAL MANAGEMENT TRIAD: THE TEACHER

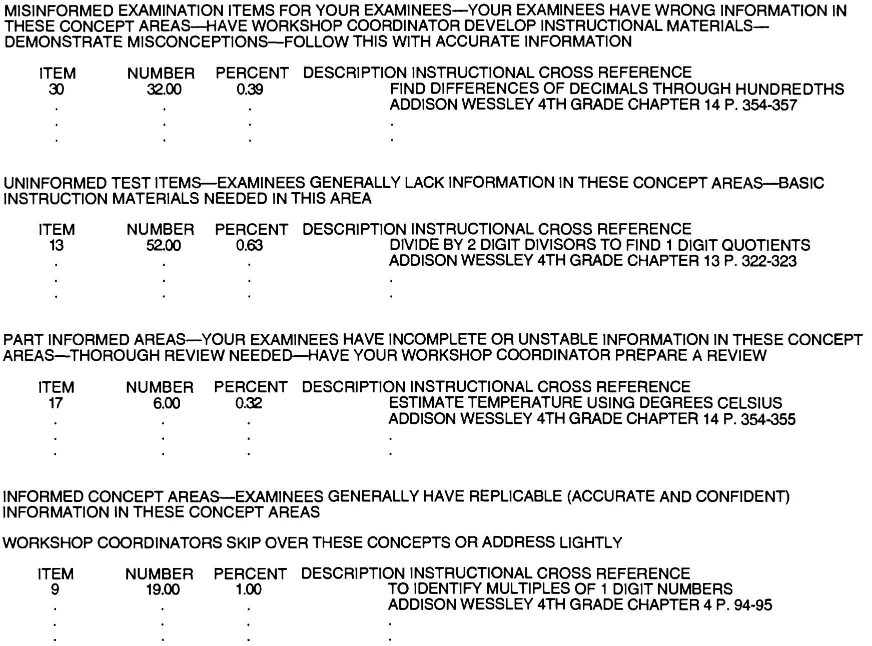
The CINP that is derived from the technology based formative evaluation procedure clusters IEPs across all students for a particular classroom or instructional unit. It is designed to provide, in a classroom setting, instructional feedback to the teacher that ranks the most "common" misinformed concepts, the most *common* uninformed concepts, etc., for a specific classroom of students. Note how teachers can use this IRT formative evaluation report information to prepare class reviews and to fine tune the school curricula to the exact and *common* information needs of a particular classroom of students (Figure 3).

```
MISINFORMED EXAMINATION ITEMS FOR YOUR EXAMINEES—YOUR EXAMINEES HAVE WRONG INFORMATION IN
THESE CONCEPT AREAS

HAVE WORKSHOP COORDINATOR DEVELOP INSTRUCTIONAL MATERIALS—DEMONSTRATE MISCONCEPTIONS—
FOLLOW THIS WITH ACCURATE INFORMATION

    ITEM      NUMBER   PERCENT  DESCRIPTION INSTRUCTIONAL CROSS REFERENCE
     16        11.00     0.58             ESTIMATE WEIGHT USING GRAMS AND KILOGRAMS
      .          .        .               ADDISON WESSLEY 4TH GRADE CHAPTER 6 P. 150
      .          .        .               .
      .          .        .               .

UNINFORMED TEST ITEMS ON THE EXAMINATION—EXAMINEES GENERALLY LACK INFORMATION IN THESE CONCEPT
AREAS—BASIC INSTRUCTIONAL MATERIALS NEEDED IN THIS AREA

    ITEM      NUMBER   PERCENT  DESCRIPTION INSTRUCTIONAL CROSS REFERENCE
     28        11.00     0.58             MAP TO SOLVE PROBLEMS (DECIMALS)
      .          .        .               ADDISON WESSLEY 4TH GRADE CHAPTER 14 P. 354-355
      .          .        .               .
      .          .        .               .

PART INFORMED AREAS

YOUR EXAMINEES HAVE INCOMPLETE OR UNSTABLE INFORMATION IN THESE CONCEPT AREAS—
INSTRUCTIONAL MATERIALS ARE INCOMPLETE OR LACK SUFFICIENT DETAIL

    ITEM      NUMBER   PERCENT  DESCRIPTION INSTRUCTIONAL CROSS REFERENCE
     17         6.00     0.32             ESTIMATE TEMPERATURE USING DEGREES CELSIUS
      .          .        .               ADDISON WESSLEY 4TH GRADE CHAPTER 14 P. 354-355
      .          .        .               .
      .          .        .               .

INFORMED CONCEPT AREAS

EXAMINEES GENERALLY HAVE REPLICABLE (ACCURATE AND CONFIDENT) INFORMATION IN THESE
CONCEPT AREAS

WORKSHOP COORDINATORS SKIP OVER THESE CONCEPTS OR ADDRESS LIGHTLY

    ITEM      NUMBER   PERCENT  DESCRIPTION INSTRUCTIONAL CROSS REFERENCE
      9        19.00     1.00             TO IDENTIFY MULTIPLES OF 1 DIGIT NUMBERS
      .          .        .               ADDISON WESSLEY 4TH GRADE CHAPTER 4 P. 94-95
      .          .        .               .
      .          .        .               .
```

Figure 3. Portion of a Class Information Needs Profile (CINP) for a mathematics classroom

## 5. INFORMATION FOR THE EDUCATIONAL MANAGEMENT TRIAD: THE SCHOOL ADMINISTRATION

The IRT procedure can also be used to generate reports that identify *common* information needs across all students and all instructional classroom units. The School (or System) Information Needs Profile (SINP) report is used to examine how instructional materials and teaching effectiveness (the signal) is being received by *all* students in a particular instructional program. This IRT report is used by educational administrative personnel to identify inordinate amounts of misinformation (suggesting the rewriting of instructional materials), lack of information (suggesting the developing of supplementary instructional materials), and partial information (suggesting the adding of greater clarity and comprehensiveness to instructional materials) in an instructional program (Figure 4).



```
MISINFORMED EXAMINATION ITEMS FOR YOUR EXAMINEES—YOUR EXAMINEES HAVE WRONG INFORMATION IN
THESE CONCEPT AREAS—HAVE WORKSHOP COORDINATOR DEVELOP INSTRUCTIONAL MATERIALS—
DEMONSTRATE MISCONCEPTIONS—FOLLOW THIS WITH ACCURATE INFORMATION

    ITEM      NUMBER   PERCENT  DESCRIPTION INSTRUCTIONAL CROSS REFERENCE
     30        32.00     0.39              FIND DIFFERENCES OF DECIMALS THROUGH HUNDREDTHS
     .           .        .                ADDISON WESSLEY 4TH GRADE CHAPTER 14 P. 354-357
     .           .        .                .
     .           .        .                .

UNINFORMED TEST ITEMS—EXAMINEES GENERALLY LACK INFORMATION IN THESE CONCEPT AREAS—BASIC
INSTRUCTION MATERIALS NEEDED IN THIS AREA

    ITEM      NUMBER   PERCENT  DESCRIPTION INSTRUCTIONAL CROSS REFERENCE
     13        52.00     0.63              DIVIDE BY 2 DIGIT DIVISORS TO FIND 1 DIGIT QUOTIENTS
     .           .        .                ADDISON WESSLEY 4TH GRADE CHAPTER 13 P. 322-323
     .           .        .                .
     .           .        .                .

PART INFORMED AREAS—YOUR EXAMINEES HAVE INCOMPLETE OR UNSTABLE INFORMATION IN THESE CONCEPT
AREAS—THOROUGH REVIEW NEEDED—HAVE YOUR WORKSHOP COORDINATOR PREPARE A REVIEW

    ITEM      NUMBER   PERCENT  DESCRIPTION INSTRUCTIONAL CROSS REFERENCE
     17         6.00     0.32              ESTIMATE TEMPERATURE USING DEGREES CELSIUS
     .           .        .                ADDISON WESSLEY 4TH GRADE CHAPTER 14 P. 354-355
     .           .        .                .
     .           .        .                .

INFORMED CONCEPT AREAS—EXAMINEES GENERALLY HAVE REPLICABLE (ACCURATE AND CONFIDENT)
INFORMATION IN THESE CONCEPT AREAS

WORKSHOP COORDINATORS SKIP OVER THESE CONCEPTS OR ADDRESS LIGHTLY

    ITEM      NUMBER   PERCENT  DESCRIPTION INSTRUCTIONAL CROSS REFERENCE
     9         19.00     1.00              TO IDENTIFY MULTIPLES OF 1 DIGIT NUMBERS
     .           .        .                ADDISON WESSLEY 4TH GRADE CHAPTER 4 P. 94-95
     .           .        .                .
     .           .        .                .
```

Figure 4. Portion of a School Information Needs Profile (SINP) in Mathematics across all classrooms at a given grade level

## 6. SUMMARY

Evaluating students on an information quality attainment standard of being informed, partially informed, uninformed, and misinformed is better pedagogically aligned (review, instruction, re-education) to teacher needs and instructional support than either a percent correct score or a percentile score. More importantly, information referenced measures of the "quality" of student information, better align themselves to the information technologies that are needed for effective educational management via specific diagnostic plans of actions directed at students, teachers, and school administrators.

As presented earlier in this discussion, the IRT procedure is an enhanced formative evaluation procedure that is *fully optically scannable* and generates a variety of specific diagnostic reports for the instructional management TRIAD in educational organizations. These reports include 1) an IEP for each student (for purposes of formative evaluation), 2) a CINP provided for the teacher (for curriculum fine tuning), and 3) a SINP provided for the school administrator (resource allocation and curriculum design).

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# 25

## Schedule Planning by Using Genetic Algorithms for Developing Educational Materials and Curricula

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### Abstract

The development and use of software products depends entirely on people. When many people make intellectual contributions to a group activity, individual ability and circumstances affect the overall quality, quantity, and schedule. It is not wise to plan time schedules manually, because the increasing number of participants will introduce many constraints.

The authors consider schedule planning for the cooperative development of educational materials and curricula an optimum combination problem and introduce solutions through the use of genetic algorithms. More specifically, this paper describes a method of schedule planning using genetic algorithms, and discusses the effectiveness of this approach.

Keyword Codes: I. 2. 8; K. 3. 1; K. 6. 1
Keywords: Genetic Algorithms, Optimum Combination Problem, Generate and Test Method; Software Process Management, Schedule Planning

### 1. INTRODUCTION

Creating schedules for the development of educational materials and curricula is an old and new problem for educational managers. The problems are not as difficult when there are relatively few objective curricula and people involved. The complexity increases significantly with an increase in curricula and participants.

One of the most important constraints in the development of educational materials and curricula is whether or not the developers of the curriculum have the necessary skills and qualifications to create the required educational materials and curricula. For that reason, there are relatively few developers of educational materials in comparison with the number of courses that need to be developed.

Since people with specific skills or qualifications are in great demand, schedules for developing educational materials and curricula are typically planned to fit their schedules. These capable people must often be engaged in many different activities at the same time. In such situations, it is important to develop plans that limit the burden on specialized people and optimize use of available manpower. For this purpose it is important to consider the development of an advanced planning tool.

## 2. OUTLINE OF A MODEL WITH GENETIC ALGORITHMS

There are five instructors who teach seven courses related to UNIX. Figure 1 shows an example of a curriculum. Figure 2 shows the skill level for each participant. Course D is new, so the teachers must develop new educational materials for D. Figure 2 also shows the procedure for developing the materials, lectures and exercises for class D and the possibility of each participant. The process is serial macroscopically, but it may be parallel microscopically. The managers leave the planning of lectures and exercises in the instructor's hands. In this model, there is no strict discipline on the order as in the Water Fall Model. Only the termination time of each process is given as a condition. If the beginning time of each course and its instructor's schedule are determined as in Figure 3, which development plan for the new class D is optimum under these constraints ?

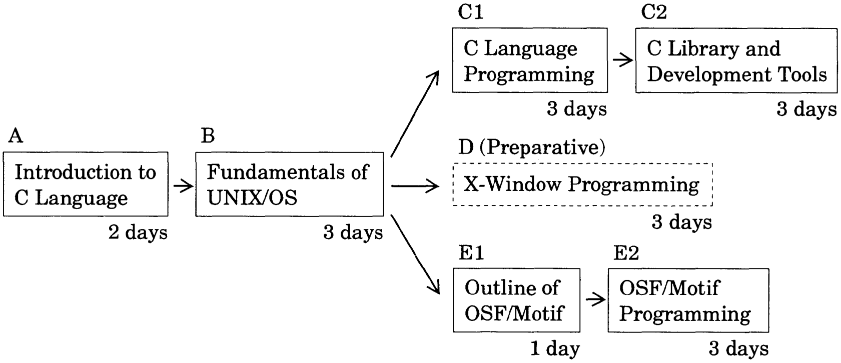

Figure 1 : Example of a Curriculum

| Course / Instructor (skill level) | A | B | C | D | | | | | | | | E |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | RA | CD | AU | DD | DR | LE | EX | EV | |
| a (middle level) | ○ | | ○ | ○ | ○ | ○ | | | | ○ | ○ | |
| b (middle level) | | ○ | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| c (high level) | ○ | | ○ | ○ | ○ | ○ | | ○ | ○ | ○ | ○ | |
| d (high level) | | ○ | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| e (Group Leader) | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| f (Manager) | | | | | | ○ | | | | | ○ | |

RA : Requirement Analysis CD : Concept Design AU : Review & Authorization DD : Detailed Design
DR : Design Review LE : Lecture EX : Exercises EV : Evaluation

Figure 2 : Skill Level of Participants

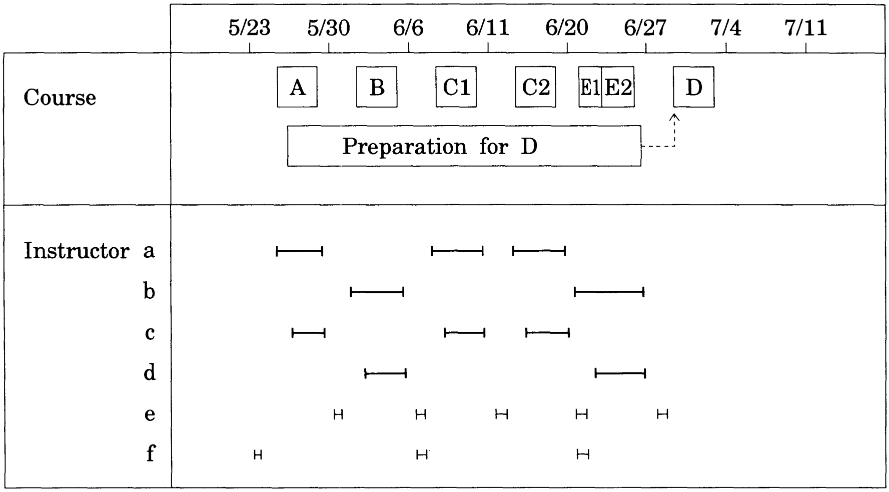

Figure 3 : Constraints on Schedule

The best method for solving this problem is to approve adaptation to constraints given after successively generating the conceivable combinations. We adapted Genetic Algorithms (GA method) as a kind of Generate and Test Method. We use the GA method which arose from the Genetic Operators Theory by J. H. Holland in 1975 for an Optimum Search Method.

In the GA method, the combinations of the working process and participants are indicated as a character set called a 'chromosome'. Each character corresponds to a 'gene'. At first, we give a random character set as the initial value.

After the model increases the chromosomes as *0*th generation, it repeats the process of natural selection. At last, we can get the near optimum solutions at the *n*th generation. By natural selection, the model generates the dominant genetic operation by cross-over between the two chromosomes, and by mutation just as with animals and plants. So we can quickly get balanced effective solutions.

The first character set contains the work descriptions (RA, CD, AU, DD, DR, LE, EX, EV) and is named chromosome X. This X becomes the basic axis of natural selection in the model. We call it the Basic Layer. The second character set (a, c, f, a, e, c, a, e) is named chromosome M. Each gene, a, c, ..., e, and gene RA, CD, ..., EV are in an one-to-one correspondence. The characters a, b, c, d, e, f indicate instructors. The chromosome M contains the human resources. We call it the Middle Layer. The structure of this Middle Layer (length of character set) is the same as that of the Basic Layer (eight digit in this model). We can select any character (gene) in the Middle Layer at will. Three instructors can take charge of the whole eight processes. There is no limit on the number of participants . All instructors in charge (namely all qualified people) must be put on record beforehand as in Figure 2. This is one of the constraints.

Similarly, the character set (wp, wp, wp, ws, wp, ws, ws, wp) indicates the chromosome L. wp and ws stand for the word processor and work station used for the work.

The chromosome L contains non-human resources. We called it the Lower Layer.

Figure 4 indicates that instructor ‘a’ takes charge of the detailed design (DD), and that instructor ‘a’ uses the work station for this work. When three instructors take charge of the same process, the character ‘a’ changes to ‘b’, ‘d’ and ‘e’, and the variety of chromosome increases. Our model is built on three layers.

The three layers seem to be limited because of complexity, however there is no restriction on the number of layers.

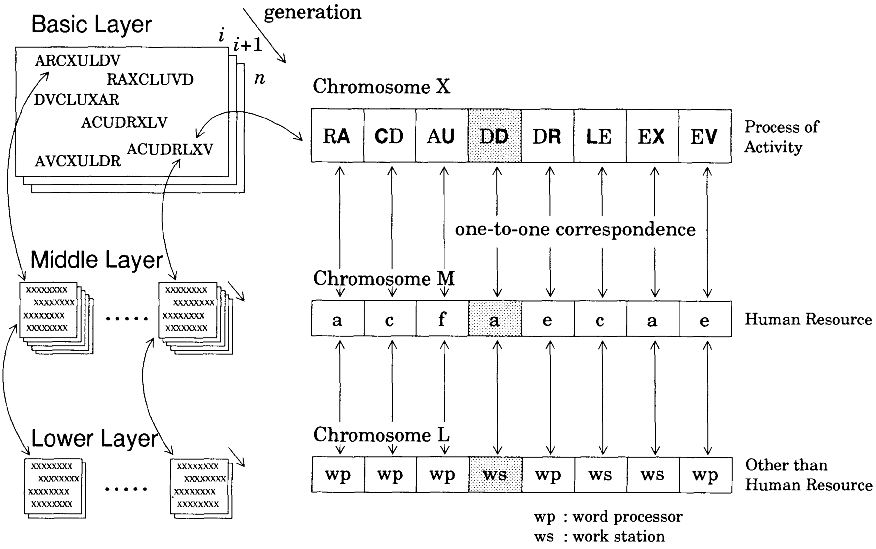

Figure 4 : Concept of GA Model

The software production model has few significant character sets of the Basic Layer. In our model, the production process in Figure 2 is basic, to exchange mutually from LE into EX is only the significant process. However we allow variation as parallel processing between CD and DD, and between LE and EX. On the contrary, there are many chromosomes in the Middle Layer and the Lower Layer. If five instructors ‘a’, ‘b’, ‘c’, ‘d’ and ‘e’ have the same degree of ability, they can take charge of the whole process. Even if we provide the constraints as in Figure 2 in our experiment, we are worried about enormous combinations. The solutions which survive the constraints become candidates for the optimum solutions.

When a combination (chromosome $X_i$) of instructors in charge is decided, the total necessary days ($Y_i$) for the job depend on each instructor's schedule. If our object is to shorten the days, we can replace this problem with the minimum solution problem.

At first, when we set a combination $X_0$ as the initial value, we can get $Y_0$. The model permits the initial values. Then the model generates $X_1$ by changing the genes in $X_0$, the model gets $Y_1$. At last, the model selects the near minimum solutions by repeating this operation. We introduced the concept of natural selection as cross-over and mutation instead of the random number generation method when the model generates the combina-

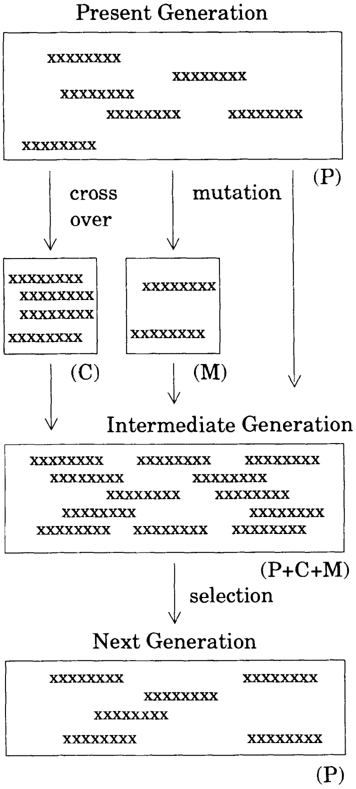

Figure 5 : Process to Next Generation

tions. So this approach is called the GA method. Our model is named 'DROSOPHILA' because of the eight genes. DROSOPHILA is a genus of small flies used in laboratory experiments in heredity.

Figure 5 shows the mechanism of evolution of generation. There are P pieces of parent chromosome. DROSOPHILA generates C pieces of child by cross-over, and M pieces of child by mutation respectively. Then DROSOPHILA generates (P+C+M) pieces of chromosome as the intermediate generation. Afterwards, DROSOPHILA selects the new P pieces of a dominant chromosome as the next generation by the select operation. A dominant chromosome means a chromosome with a high survival rate.

In the case of the minimum solution of $Y=f(X)$, a survival rate of the chromosomes which remain at the next generation is represented by the expression $(1-f_i/\Sigma f_i)/(n-1)$

Figure 6 shows the search mechanism of GA. We can recognize that the candidates of the optimum solution boil down with the progress of generation.

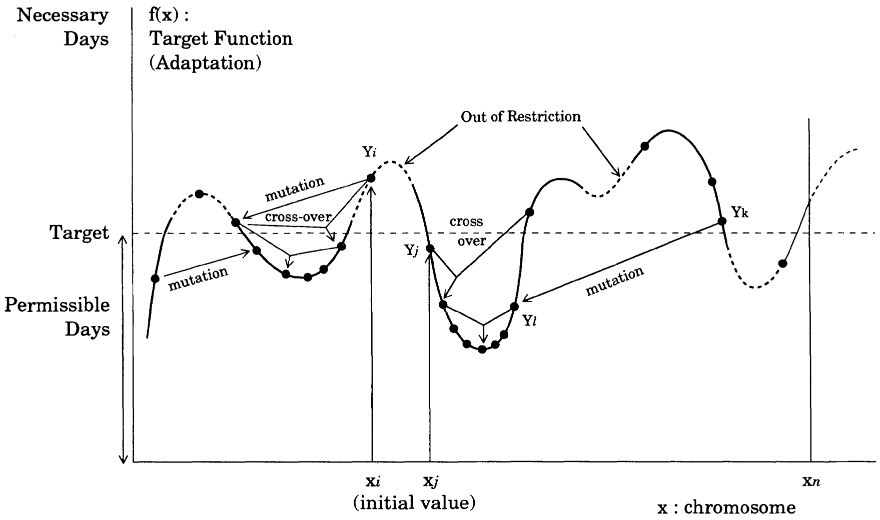

Figure 6 : Search Mechanism by GA

## 3. OUTPUT, EVALUATION AND CONCLUSION

Figure 7 and Figure 8 show two samples of desirable schedules for development of the new course D.

The release from the complicated desk work by using the planning tool DROSOPHILA has great significance. The results went beyond our expectations, and are listed below :

① short time selection of the desirable solutions
② dissolution of the local solutions by preconception
③ little influence created by fluctuating input data
④ easy scrap and build

The GA method is certainly 'Robustness' as Holland has suggested.

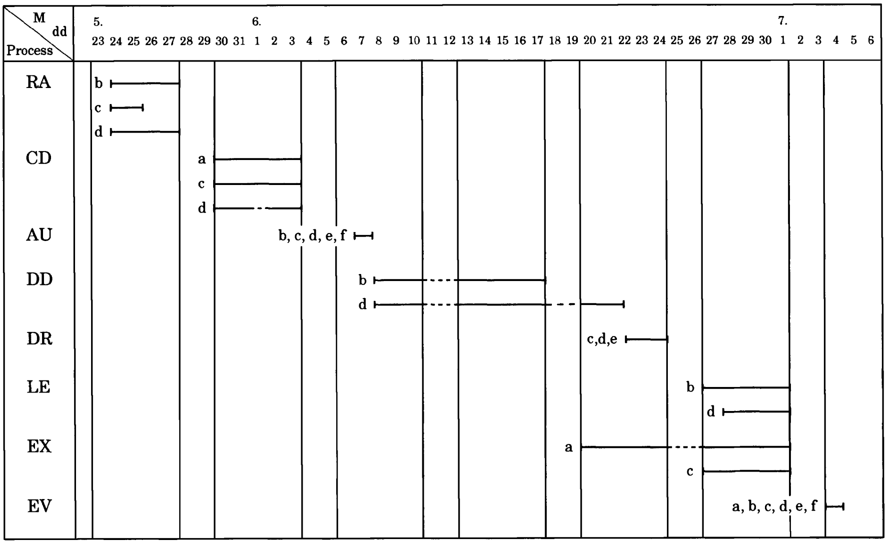

Figure 7 : Output Image (One Solution)

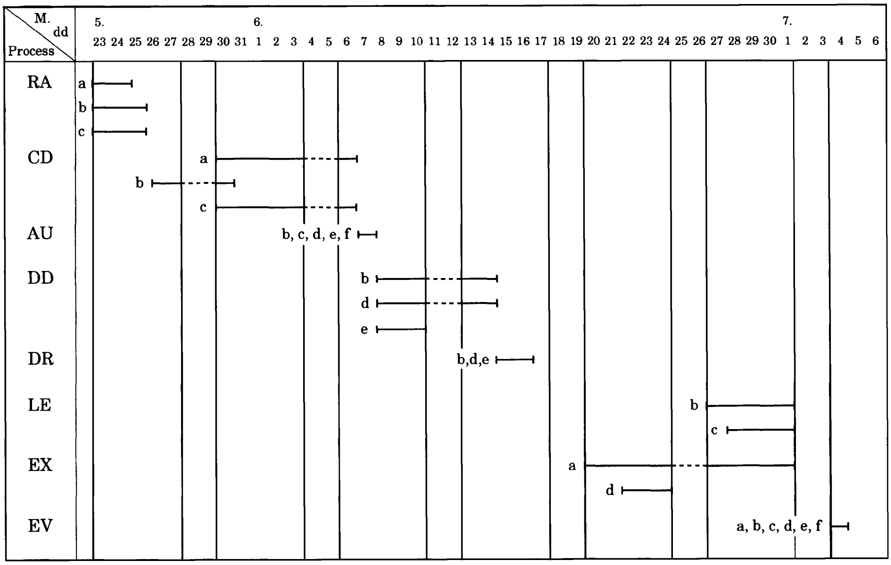

Figure 8 : Output Image (Another Solution)

## 4. ACKNOWLEDGMENTS

The authors would like to thank Prof. Sam Stern (Oregon State Univ.), Miss Chieko Hashimoto and Mr.Scott K. Bachmann (Hitachi Ltd.) for their useful comments and their help in the editing of this paper.

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# The Use of Information Technology in Educational Counselling: Applications for High School Counsellors

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## Abstract

Information Technology (IT) is a universally accepted educational instrument designed to increase the effectiveness and efficiency of the educational system. Computers are used for instruction as well as learning in the school system. An increasing variety of courseware, both "traditional" and "open-ended", is available for teachers and pupils teaching and studying different subjects offered by schools and empirical evidence indicates that well-planned and suitable courseware contributes positively to the cognitive and affective needs of pupils.

However, in addition to the utilisation of IT for teaching and learning, computers can be effectively used for educational counselling. Data storage and retrieval that provide counsellors with up to date information on pupils in need of counselling can dramatically increase the efficiency of the counselling process. The effectiveness of Student Selection and Placement, Diagnostics, Reports to Parents and Teachers, School Faculty Consultation, and Statistical Data Analysis (important functions carried out by educational counsellors) can be significantly improved through the use of IT. It is suggested that educational counsellors investigate the possibility of routinely utilising the school computer in their work in order to improve counsellor effectiveness and efficiency.

Keyword codes: K.3.m1, K.3.m2, K.3.m3, K.3.m4, K.3.m5, K.3.m6, K.3.m7
Keywords: Information Technology, Educational Counselling, Student Selection and Placement, Diagnostics, Reports to Parents and Teachers, School Faculty Consultation, Statistical Data Analysis.

## 1. COMPUTERS AND EDUCATION

Robinson [1], in summing up almost twenty years of experience regarding the use of computers in the educational system, declared that it is now commonly accepted that computers should play a central role in education. Other commentators, however, recognised that the educational impact of computers within the classroom has not as yet been efficiently maximised. Moore [2] and Dunn and Ridgeway [3] confirmed that the computer has not as yet become the potent force in the educational system as expected.

Hoyle [4] predicted that the infiltration of computers into the school system may well bring about the long dreamed of educational revolution and, more specifically, the teaching and learning revolution. The computer can serve as a vehicle for improvement of students' learning [5], and for example, Hativa [6] and Mevarech [7] indicated that Israeli elementary school pupils who studied mathematics and science through the medium of computer-assisted instruction completed their study units more rapidly and accurately than their counterparts who studied the same subjects by traditional and older established teaching methods. However, progress has generally been limited to computer assisted instruction and learning and the most rapid developments have been made in these specific areas.

### 1.1 Computers and Counselling

Katz [8] postulated that in addition to learning and instruction there are two other major areas in education can conceivably benefit from the use of computers which may be described as the climax of technological development. These are educational administration and organisation; and auxiliary specialisations in education such as counselling. Less attention has been paid to the topic of administration and organisation or auxiliary specialisations than to learning-related topics in the literature [9]. Nevertheless, the advantages of computer utilisation in the areas of administration and counselling are evident in such modes as guidance, testing, curriculum evaluation, records and scheduling [10], as a management tool, and as a storage and retrieval device [11]. As such, the computer facilitates the work of both the school principal and the school counsellor.

Counselling, which may be described as the field in education which specializes in the concern for the individual's well-being, needs and development, is an essential facet of the total educational process. The key question that remains is whether the computer's proven contribution to learning and instruction can be successfully transferred to the field of counselling. Super [12] answered this question stating that although radical innovations such as computer assisted counselling are likely to encounter initial resistance, after familiarisation and proven effectiveness, counsellors will readily utilise computer processed information. The computer is an especially potent tool with regard to information storage and retrieval [13], counsellor accuracy and efficiency [14], improved record keeping [15], decision-making strategies [16], and counselling-related simulations [17]. Crabbs [18] added that computer assisted counselling is a cost-effective method of tabulating and manipulating data. Pogrow [19] summed up the potential of the computer for the counsellor as a delivery system designed to improve school effectiveness and efficiency by reducing personnel time that would otherwise be required for the same task.

The goal of the computerised counselling package described in this paper is to provide high school counsellors with an efficient counselling instrument. This package allows for the utilisation of all information vital to the diagnostic process and enables the counsellor to evaluate educational situations with improved accuracy. The main innovations suggested by computerised counselling are time saving, information gathering, information processing and retrieval. Information which usually takes days or even weeks to process by traditional methods is processable within minutes with the assistance of the computer. The computerised counselling package does not demand radical changes in counselling methods. The package provides the counsellor - familiar with traditional counselling procedures - with a potent and sophisticated instrument for data storage and information processing thus paving the way for improved efficiency, depth and utility in the counselling process while counselling by well-known and acceptable methods.

## 2. COMPUTER ASSISTED COUNSELLING PACKAGE

The computerised counselling package provides the following services:

1. Student Selection and Placement
2. Diagnostics
3. Reports to Parents and Teachers
4. School Faculty Consultation
5. Statistical Data Analysis

### 2.1. Student Selection and Placement

The computerised counselling package offers the counsellor facilities for determining student selection and placement on the basis of entrance examinations, standardized achievement tests, intelligence tests, aptitude tests or other relevant measures. Students can be accepted and assigned to relevant classes on the basis of homogeneity or heterogeneity of learning levels, ethnic origin, socio-economic status or any other criteria congruent with school policy. Students can be placed in differential streams or tracks according to their ability in those subjects where streaming or tracking exists within the high school framework. This facet of computerised counselling saves much time and promotes counselling efficiency in school selection as well as class, stream or track formation.

### 2.2. Diagnostics

Diagnosis of a student will be based on the following computerised counselling information:

a. Biographical Details
b. Student Background
c. Academic Achievement
d. Standardized Testing
e. Social Standing

#### 2.2.1 Biographical Details

Biographical information pertaining to all students is entered into the computer at the beginning of the school year. When a student needs counselling this information is immediately available. A biographical printout can include such data as home address, parents' educational levels, parents' occupations, number of children in family, birth order of subject and number of rooms in apartment.

#### 2.2.2 Student Background

Starting from birth, all relevant developmental information is recorded on the computer. Medical, psychological and social development - based on physicians' diagnoses, intelligence, aptitude and personality tests, and teachers' as well as peers' social evaluations - is encoded and made available for retrieval should the counsellor wish to refer to the student's medical, cognitive, affective or social background for any particular reason during the course of his or her studies at school.

### 2.2.3 Academic Achievement

All achievement-oriented information is recorded on the computer. The type of evaluation - such as class test, standardized test, homework assignment - is indicated as is the grade achieved. This information enables the counsellor to check student achievement and assess progress over a given period. In addition, the computerised counselling package allows the counsellor to compare student grades with the class or group average in any particular subject or group of subjects. The computerised package also allows for the calculation of a frequency distribution of grades, and provides a printout of students who deviate from the mean by more than one standard deviation. Students more than one standard deviation below the group mean usually have difficulty keeping pace with their peers in the academic sphere, and perhaps in other areas as well. This printout focuses attention on these low functioning students, and provides a sound basis for educational interventions.

The software package offers the option of a "Diagnosis Sheet" printout of variables considered by educational experts to be central to successful academic achievement. Key variables, such as ability, perception, thinking, learning, memory, concentration, diligence, creativity, maturity, and discipline, are readily availble from the computerised package. Teacher evaluation of these key variables can provide a clear picture of the students' problems as well as important information for the counselling process.

### 2.2.4 Standardized Testing

An important aspect of diagnostics and counseling is the assessment of student potential and achievement as compared to standardized norms. In the computerised package, the student is able to take standardized tests by computer. Immediate computerised results indicate the student's position compared to the group norm. This information allows the counsellor to suggest stream, track or class placement with a greater level of efficiency and speed. The computerised counselling package includes standardized tests such as MILTA - the Israel Group Intelligence Test [20], and the Standardized Progressive Matrices Test [21].

### 2.2.5 Social Standing

The social standing of students in their respective classes may be obtained through the medium of sociometric testing conducted with computerised counselling. The student's social status in the classroom usually adds important correlative information that can be used to verify or add to the initial diagnosis of the student's problems.

### 2.3 Reports to Parents and Teachers

Computerised counselling also allows parents to be kept informed of the students' progress and to express their opinion to an authorised faculty member. A periodical report is presented to parents and teachers on the basis of student achievement data fed into the computer over any specified period of time. When presented with a report, the parents are asked carefully to check the student's progress, to make any comments they feel appropriate and to return the signed report with comments to the class teacher.

### 2.4 School Faculty Consultation

Computerised counselling affords the counsellor the opportunity to check progress made by the teachers in their respective classes or groups. Significant differences found between parallel classes or groups for common subject matter or significant differences for the same classes or groups in different study topics, enable the counsellor more readily to diagnose instructional problems which typify specific teachers. Learning problems which characterise particular classes can also be diagnosed in order to assist teachers. With the computerised data the counsellor is able to advise the teachers concerned how to improve the situation in their respective classes or groups. The counsellor is also able to efficiently provide the school principal with relevant information, such as student achievement levels, inter-class differences, and instructional problems that characterise certain teachers, so that he or she may cope more readily with the implementation of school policy regarding learning and teaching effectiveness and improvement.

### 2.5 Statistical Data Analysis

Computerised counselling contains a basic statistical package including correlation, and t-test options in addition to the mean and standard deviation analyses already described. Statistical analyses of test scores at the individual and group levels enable the counsellor to make effective group and individual comparisons based on group norms. The counsellor is also able to present the principal and teachers with graphic representations of individual student and class achievements in the different subjects studied at school.

## 3. CONCLUSION

The use of the computerised counselling package at the high school level should provide the counsellor with a tool that can significantly cut down time and effort spent on data storage and retrieval as well as affording efficient information processing vital for effective counselling, consulting and coordination of student services. The counsellor could use his or her time more profitably as a result of the speedy and efficient service provided by the computerised package, without effecting any radical changes in the counselling processes traditionally used by school counsellors. Thus computerised counselling should add immeasureably to the effective contribution made by the counsellor to the students, faculty and parents. It is suggested that a comprehensive study be undertaken in order to pinpoint the advantages (and disadvantages) of computerised counselling. However, on the basis of preliminary information already available, it appears that a computerised counselling package is well worth considering as a positive technological medium that contributes to the improvement of the counselling process.

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# 27

# Having an "Assistant" makes better teaching

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## Abstract

This paper presents a theory of assessment and appraisal in school curriculum for improving teaching and achieving the school's educational goals. The problem of assessment created by the wide range of tests is how to design them and to implement them in schools on one hand and how to evaluate them afterwards, on the other. This paper describes software especially designed to solve the second problem. The software of "*Assistant*" and "*Hameaged*" was built for teachers and other educators who have no previous experience with computers or in statistic. It is user- friendly, making test analysis easy and reducing the need for professional handling. Teaching also improves using this software.

Keywords Codes: K.3.1; J.4; D;
Keywords: Computer uses in education, Social and behavioral sciences, Software.

## 1. INTRODUCTION

An educational system is constantly looking for new ways to improve itself. As students' achievements are the main purpose of a school's existence, means of assessment should be found in order to improve teaching and studying and thus to make the school function better. According to Eisner [1]"Assessment in schools is sometimes used to help teachers provide remedial help to students who need it and sometimes to provide feedback to teachers on the quality of their professional work. The assessment of teaching can help a teacher become more reflective about his or her own performance so that it can be improved. Assessment can focus on the quality of the program that is being provided. If the program's quality is poor to begin with, the quality of teaching does not matter much. All the functions can be reduced to the assessment of the program that is provided, the quality of teaching, and outcomes that result from the interaction of the first two. Program evaluation, teacher evaluation, and student evaluation are the major areas of focus for any form of educational assessment."

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* "*ASSISTANT*" and "*HAMEAGED*", are products of"*RENANIT*" Software 22 Havradim st. Yehud 56275 Tel/Fax: 972 3 5363212

## 2. ASSESSMENT IN SCHOOL

According to Levi [2] good assessment and feedback should be curriculum embedded and planned for the most part by the classroom teacher who knows exactly what was taught and how. On the other hand, the classroom and the teacher are part of an entire system. Therefore, there must be a way to assess the classroom as a unit that is a part of the school system and the school as part of the educational system in the district or the country. It is essential that these tests do not become "psychometric imperialism".

For a test to be "holistic and rich" it must be designed to fit the right discipline and the right demands. Tests should be designed so that there will be a significant difference between academic tests and practical tests. A test should check cognitive, effective, and practical behavior. A test can be disciplinary or interdisciplinary and take into account daily life and practice. A test can be based on scholastic material, basic skills, or other performances. In any case there should be a certain proportion among all these, and each test should provide a means of determining the effectiveness of the teaching strategy that was chosen in order to serve the school's educational ideology.

A teacher who plans strategies for teaching and for testing accordingly should be able to analyze the tests quickly and objectively in order to make the right decisions and to use this information for future planning. Test analysis can be done manually, but this takes a lot of time and effort. On the other hand, appropriate software could do this much faster and easier. This paper will present some software that makes test analysis possible: the "*ASSISTANT*" for a teacher in the classroom and "*HAMEAGED*" ("Combiner") for headmasters or supervisors in administration.

## 3."ASSISTANT"-AN AID FOR THE TEACHER IN THE CLASSROOM

As mentioned above, planning and designing the test according to the school's educational goals is the first and most important step in test analysis. There is a wide range of test procedures for appraisal: oral tests, written tests, multiple-choice tests, wide range tests, performance tests, individual tests, group tests, self-esteem (portfolio), and peer-esteem. All of them must be analyzed in order to serve their intended purpose of showing achievements, group difficulties, and curriculum problems.

Using the "*ASSISTANT*" software makes teacher interacts with the computer in order to get his or her tests analyzed . He or she decides what kind of test is needed and writes it into the software. The teacher must decide how many subordinate subjects are to be checked in the test, what kind of test it will be, and then decide accordingly how many questions or tasks the students are to perform, what is the expected outcome of the tasks, and how to score each task. The computer will show a table like the one shown below, and the teacher will fill in all the necessary details.

School:____________ Class:____________
Test subject:______ No. of questions:____ Date:_____ No. of subordinate subjects_____
Subordinate Subjects:
No.1____________ No. 4____________
No.2____________ No. 5____________
No.3 ____________

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Subordinate subjects: | 1 | 1 | 4 | 5 | 4 | 3 | 2 | 1 | 3 | 5 ...... |
| Value of question: | 5 | 2.5 | 8 | 5 | 20 | 4 | 5 | 2.5 ..... | | |
| No. of question: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10.... |

There are several other details that the teacher will be asked to add, such as teacher's name and the type of class. The teacher can assign any amount of points (from 5 to 100) for the test, and the software will change it to percentages.

## 4. "OPEN" AND "MULTIPLE-CHOICE" TESTS

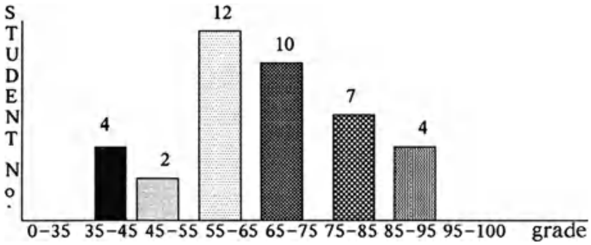
There are two possibilities for marking the tests: *multiple-choice* tests with no need to check and correct the test before entering the student's answers to the computer, and "*open*" tests where each part of the test is valued differently and the teacher has to read and evaluate each part independently. To facilitate this process the teacher estimates each task and records how many points are needed in order to mark it ideally. Later on, when the student's score is entered, the computer translates it to the exact percentages of the question or task on hand.

As mentioned above, there are all kinds of tests and means of assessment that can be analyzed by "*ASSISTANT*" provided the planning is carefully done. Scoring the tests and entering the results to the computer gives the teacher a wide range of information. This information includes graphs, charts, statistics and verbal information. Some of this information concerns the whole class or several classes together. It includes the following details: average marks, standard deviation, and reliability score. The graphs show the number of students in each grade. There is another graph (like the one below), showing percentages for each grade in the classroom. Other graph shows personal problems and material difficulties

**Table 1.**

**Class profile**

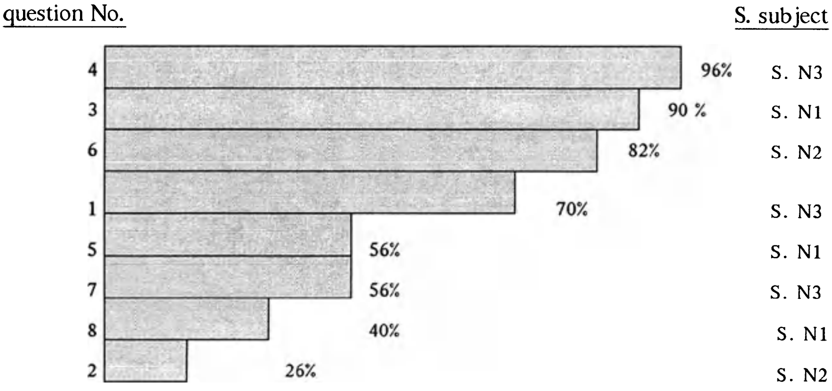
| | | | |
|---|---|---|---|
| School name: | "Success" | Number of questions : | 12 |
| Class: | 7th grade | Average score : | 70 |
| Test subject: | Bill of human rights | Standard deviation: | 25.6 |
| Number of students | 39 | Reliability: | 0.78 |



Another graph shows the degree of difficulty of each question or task in the class.

**table 2.**

**Degree of difficulty of tasks (questions)**



The information shown above is not sufficient for decision making. In order to take definite steps the teacher has to have more details and "*ASSISTANT*" has to provide directions. Sometimes verbal and personal information such as names of students (and their scores) who have shown sufficient mastery of the material (the teacher decides what constitutes "sufficient mastery"), middle-level and poor students (and their scores), is given with the report on each subordinate subject and on each task or question. The single question report gives details and names of students who did not answer the particular question.

**Table no. 3**

**Students Achievements on task**

| HIGH ACHIEVERS | MEDIUM ACHIEVERS | LOW ACHIEVERS | NO ANSWER |
|---|---|---|---|
| joe gil (100) | rina tal (70) | amir ziv (55) | sal lan |
| ron bar (88) | meny s. (70) | zila n. (54) | miriam h. |
| yuval b (88) | shimi g. (66) | zvi b. (54) | yoel t. |
| sigal s. (80) | gil f. (62) | rimona h.(48) | |
| dani m.(76) | | | |

Mastery level: 76
Poor level: 56

On seeing these reports the teacher will have the opportunity to ask himself or herself relevant questions: Was the test designed correctly? Did the test really reflect the material that was dealt with in class? Were there any questions that could have been phrased better? If the answer to the last question is ”yes”, then the teacher can change the score of such questions and get the whole test recalculated automatically.

With the answers to the above questions the teacher can start planning strategy. Should the material be reinforced for the whole class, or should the reinforcement be given to the non-high achievers? Will the help be given individually or in groups? Will the groups be homogeneous or heterogeneous?

We could stop at this point and be satisfied with what we have, but there is more. Sometimes the teacher would like to view the profile of the test in a different ”mirror” that was prepared in advance. In this case there will be no problem, and the teacher will mark the questions that he or she wants to regroup and then get all the above reports on the new setting. Or again the teacher may like to give a detailed report on test achievements to the student or his or her parents. With *”ASSISTANT”* software a personal report can be obtained on each student showing the questions that were not mastered, subordinate subjects that should be reinforced, scores compared to class average, and the score in the preliminary test if this is a corrective test.

Each of the mentioned reports, and more, presented on screen and can be printed out as hard copy. Some reports sum up the entire information and can be obtained only as hard copy.

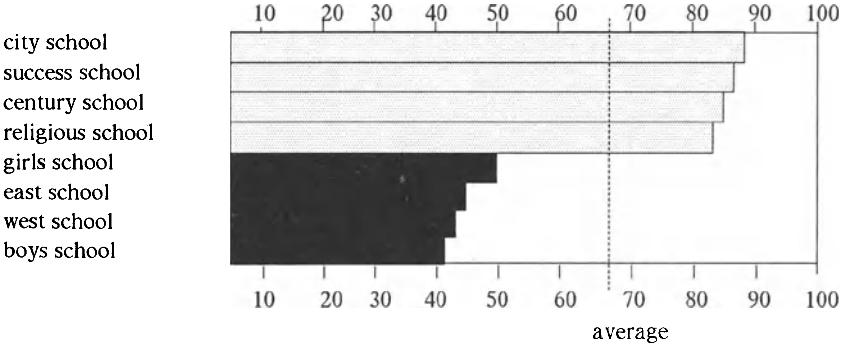
## "HAMEAGED" A USEFUL DEVICE FOR HEAD MASTERS AND SUPERVISORS

We noted earlier that each class is part of a school and each school is part of a system. Therefore, those in charge of these units -a school or schools in a district need to obtain proper information in order to make decisions and have the system function optimally. We use "*HAMEAGED*" (Combiner) software which was designed to process the data from "*ASSISTANT*" for comparative information. With "*HAMEAGED*" information a headmaster or supervisor can get a detailed profile of the school or district. As in "*ASSISTANT*", the data from "*HAMEAGED*" is presented in graphs, statistics, and verbally. The reports from "*HAMEAGED*" give details of a class as a whole rather than that of an individual student. Some reports compare classes in the same school: general achievement of each class, class achievements in subordinate subjects, and class achievements in each question or task in the test. Similar reports are made for a district, the comparison is among schools as well as among classes in the same school. With this information those in charge can make decisions such as: Which school must be reinforced and by what means? Should this be accomplished by in-school teacher training, addition of academic hours, rearrangement of class attendants, discharging a teacher, or promoting a teacher? Without proper information a sensible decision cannot be made. Using "*Assistant*" and "*Hameaged*", makes it easy to have that information handy.

**Table no. 4**

**Profile of Schools in a district**

Subordinate subject results in the schools



*the graph shows each schools status, and achievements it is also presents the average score of the whole district. Four out of eight schools met the demands and their achievement is high. these schools score is higher then the average of the district* (68) *and of the minimum required in the test. Four of the schools did not stand up to demands.*

The above graph presents schools status in a district as a whole. In order to get farther details which gives the one in charge more information for better understanding and higher ability of decision making, there is another chard with detailed information, like the one showing below.

**table no. 5**

**Profile of schools achievements in a district**

| | | | |
|---|---|---|---|
| Date: | 10.7.94 | Number of students: | 1926 |
| District name: | Galilee | Number of subordinate subjects: | 4 |
| Test subject: | Creative writing | Number of questions: | 34 |
| Number of schools: | 8 | | |
| Average: | 64.5 | Standard deviation | 22.5 |

| School name | No. of Students | average | class | sub1 | sub2 | sub3 | sub4 | Students | ave. |
|---|---|---|---|---|---|---|---|---|---|
| City school | 244 | 88 | 7c | 90 | 86 | 97 | 89 | 40 | 92 |
| | | | 7b | 84 | 89 | 89 | 90 | 42 | 88 |
| | | | 7a | 85 | 80 | 86 | 88 | 42 | 86 |
| | | | 7d | 80 | 86 | 84 | 89 | 40 | 86 |
| Success school | 126 | 86 | 7c | 90 | 84 | 90 | 88 | 43 | 88 |
| | | | 7a | 89 | 85 | 88 | 88 | 42 | 87 |
| | | | 7b | 75 | 90 | 92 | 86 | 41 | 83 |
| Century school | 300 | 84 | 7b | 87 | 90 | 95 | 86 | 43 | 92 |
| | | | 7d | 80 | 85 | 90 | 88 | 43 | 86 |
| | | | 7a | 76 | 90 | 77 | 80 | 43 | 81 |
| | | | 7c | 55 | 60 | 65 | 70 | 43 | 63 |

*This is a part of a long chard showing full details on each class and every school in the district. It is a mean of assessing the classroom as a unit and a part of the school system and the school as part of the educational system in the district or the country. This table destination is the supervisor. A headmaster will be getting the same information without other schools' identification.*

*Using this chard enable the supervisor to detect problems in his/her schools and try to deal with them. On the other hand, the headmasters obtaining information which shows them their school status comparing to other schools and gives them opportunity to assess their school more objectively then having only their own school's information.*

Analyzing tests and assessing school performance is very important, but one must keep in mind the risks incurred in missing the aim of tests. A test should be a means of support and reflect student accomplishments. It should be authentic, assessing cognitive performance but without being too intricate. A test should indicate changes in students' scholastic progress, suggest individual differences between students and indicating their causes: cognitive, affective, or socioeconomic reasons. It is imperative that a test be based on common criteria for all students so that analyzing it will give significant evidence of the individual's ability and performance.[3]

## 6. CONCLUSION

The new assessment practice is intended to help all participants in the educational system: students, teachers, and administration-each one in its unique part of the delicate fabric of schooling. Learning how to learn, as the saying goes, is a fundamental educational aim, and since learning is a verb, seeing it unfold both haltingly and smoothly is a primary aim of diagnostically useful assessment, and therefore an important criterion for creating and appraising new assessment practice. Add to this the new technology, adapt the right software, and you will have a chance to make a real change in the educational system and improve it.

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# 28

# Educational management in Israeli elementary schools

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## Abstract

Educational management should be part of every well designed instructional computer system. A description of how pedagogical management is implemented in the systems developed by CET, both in the aspects of student-computer interaction and of class activity, is presented.

Keyword codes: K.3.1
Keywords: Computers Uses in Education, CAI, CMI

## 1. SCOPE

This paper describes the educational management systems installed in some 700 Israeli elementary schools by the Centre for Educational Technology. Some 200,000 students, using 15,000 computer terminals, benefit from these systems.

## 2. THE CENTRE FOR EDUCATIONAL TECHNOLOGY

The Centre for Educational Technology is an independent non-profit organization dedicated to improving the Israeli educational system. Established in 1971 and initially endowed by the Rothschild Foundation (England), CET finances its activities mainly through the services it provides to schools, and receives financial assistance from various foundations.

In pedagogical terms its credo may be summarized by saying that students differ from one another in ability, background, experience, interests and level of knowledge, and that educational and training systems must recognize and respect these individual differences, and allow each student to learn according to his own capabilities and preferences.

Serving these ideas, CET's Department of Computers in Instruction has pioneered the utilization of educational management systems in Israeli schools since 1977.

## 3. THE SCHOOL COMPUTER SYSTEMS

The idea that the school computer system has to support the learning process of each student, providing each one with the assistance appropriate to her stage of cognitive development, was clear to us since the first TOAM systems were installed in 1977 (TOAM is the Hebrew acronym of "Computer-Assisted Testing and Practice"). Nevertheless, it is only now, with the development of our newest system, RAMA 3, which enjoys all the advantages of present day technology, that we can give this idea its full expression.

RAMA 3 is a complete computerized instructional system, composed of an instructional facility, an administration facility, and a software and courseware library.

The **instructional facility** consists of a personal computer equipped with all the software necessary to allow for a rich and varied student-computer interaction. All the personal computers installed in a school are linked by a local area network to the software-courseware library and to the administration facility.

The **administration facility** is the repository of student, course and statistical records necessary for instruction, student guidance, monitoring of student progress and evaluation, and improvement of instructional programs.

The **software and courseware library** includes all the computerized instructional materials designed to serve the multiple needs of different students and varied instructional processes. A balance has been achieved in the library between guided instruction (e.g., tutorial or testing and practice programs) and exploratory activities (e.g., simulations, games, tools).

## 4. THE STUDENT-COMPUTER INSTRUCTIONAL DIALOG

It is important to distinguish between two different types of instructional computer programs: those that can be presented in computer-guided mode, and those that can be presented only in free mode. The distinction between the two modes lies in the fact that in computer-guided programs the computer is able to judge whether the student is able to perform certain tasks correctly, whereas in free mode, this judgment is beyond the program capabilities. To exemplify, a program that presents a student with exercises whose correct answer is perfectly defined can be used in computer-guided mode; on the other hand, a student writing an essay using a word processor is working in free mode, because no word processor is able to judge the quality of the essay being written.

Both modes of interaction are equally important and attend to different facets of the instructional process. Computer-guided programs are essential if we want to provide instruction adapted to each student's needs, and they constitute the critical link with the teacher by transmitting to her or him objective and updated information about each student's status, progress and difficulties. Unfortunately (or not) computer programs cannot cope with sophisticated student inputs, and we should not limit the student-computer interactions to those which match our programming limitations. Free mode is essential for the development of exploratory skills, for learning how to enjoy all the possibilities offered by the joint technology of communications and computers, and as a tool to help in fostering creativity.

Let us describe how the student-computer interaction is performed in our school computer systems, first in computer-guided mode, and then in free mode.

When a student starts his activity at a terminal (a networked computer station), he must first identify himself. When the right to receive instruction is established, the basic student parameters are retrieved from the administration files in order to start initializing the **student model.** When a computer-guided courseware is then selected, the student data pertinent to this course are retrieved also from the administration files, and the initialization of the student model is completed. At this point the student model includes all the available information about background and performance needed by the **pedagogical model** to decide on the appropriate instructional steps. The term "pedagogical model" embodies all the programming routines which, in some sense, try to simulate a teacher's decision process, i.e., what a good teacher would decide is best for the student to do when supplied with all this very precise information about the student's performance.

The pedagogical model's decision is expressed as a request to the **knowledge model** (embedded in the courseware or the courseware library) to present information to the student. This information may be expository or may require a student's answer (e.g., an exercise). This information is decoded from the library and presented on the student's screen. The (real) student's response to this stimulus will (immediately!) update the student model, and the pedagogical model will base its next decision on this updated model. This loop continues until the activity in this particular courseware ceases and, at that point, the data from the updated student model is stored in the specific student record on disk. Furthermore, all the statistical information related to this interaction with this courseware is stored in the specific courseware file, to be analyzed by the development team in order to improve, periodically, the courseware library.

The free-mode interaction is much easier to describe. Once the student's right to work with the system has been ascertained, he may interact with any free-mode program in the library as he wishes, without any supervision or guidance.

For the sake of completeness, let us mention an intermediate mode. Computer-monitored programs are free programs in which, nevertheless, data is collected about student activity. This information is not used for computer guidance (otherwise the program would be guided), but rather to convey information to teachers (who may want to know which computer activities a student invests his time in) and to developers (for improvement purposes).

## 5. A PARADIGM: TESTING AND PRACTICE

Testing and Practice (T & P) programs, born out of the pioneering efforts of Prof. Patrick Suppes at Stanford University, still constitute the best example of computerized educational management which helps improve class instruction.

The design of these programs derives from the experimental results of evaluating student performance in different school subjects, which show an enormous variance among children in the same class. T & P programs say: instead of continuing on the false assumption that all students in the same class are able to cope with the same instructional tasks, let us ascertain the cognitive level each student has reached in any given subject area, and let us continue, from that particular level, her instructional process.

CET has developed three major T & P programs, covering arithmetic for elementary school, Hebrew reading comprehension for elementary school, and reading comprehension in English as a Foreign Language, for elementary and junior high schools.

In each of these programs the student-computer interaction begins with an adaptive testing process whereby the effective "functioning" level of each student is determined. Thus, instead of blindly assigning sixth grade level exercises in arithmetic to a sixth grader, the system will carefully test the student (in a process that is accomplished usually during the first two weeks of the school year) and if the student is not able to answer exercises beyond the third grade level, those are the exercises the student will be asked to answer.

When testing is finished, the teacher receives detailed class reports showing each student's level in each one of the three major subjects mentioned. From then on, the teacher should plan his or her class activities according to this reliable information provided by the computer management system. The reports available to teachers are designed to cope with the various needs that may arise when integrating class and computer activities. For instance, a teacher who wants to teach a specific topic and is willing to group students according to their knowledge in the topic, may request a "histogram report", where student names appear ordered according to the proficiency levels in the topic. With this help, forming the groups is a very easy task.

The class reports also include special symbols to alert the teacher about students' difficulties on particular subtopics, thus allowing for a very efficient treatment of these students' real needs. It is important to note that these special symbols add a dynamic component to the status report: In addition to knowing at *which level* a student is at each topic, the special symbols provide information on *how* she is performing.

It goes without saying that it is not enough to install computers in schools for teachers to change their instructional style. A strong effort is being made to provide the teaching staff with appropriate training and long term support. The 700 schools mentioned in section 1 are served by a team of nearly 50 CET instructors who provide a concentrated initial training (both in terms of pedagogy and of courseware acquaintance) when the computer system is installed, followed by monthly visits to each school in order to examine, with each teacher, the progress reports in each subject, and to provide advice on class organization. Each courseware addition is accompanied by in-service training to the teachers that may use it.

In addition to the detailed reports available to teachers, the computer management system produces summary reports for the school principal. These reports include global statistics about class performance and schematic histograms showing the dispersion of student levels for each subject where T & P courseware is being used. For a full description of the instructional administration included in these systems see [1].

Reports on the significant impact of this type of computer support on educational gains have been widely published. These important gains are the result of direct effects (students working at a level which is optimal for their cognitive development) and of indirect effects (more individualized teaching methods and better supervision, as a consequence of the management component of the instructional system) [2]. It should not come as a surprise that, if a computer program is able to reach sound pedagogical decisions in its interaction with students on the basis of the information stored in the **student model**, teachers may benefit even more from this same information. In fact, the evolution of the teacher's instructional style, from frontal instruction to a student-tailored approach has been documented in [3]. Another important consideration is that the groups that benefit more from the computer support are precisely those whose needs are less attended to in frontal teaching: the low achievers and the high achievers [4].

## 6. THE INTEGRATION OF GUIDED AND FREE MODES

The courseware and software items stored in the library are classified in order to facilitate access to them. The classification schema is not UDC or Library of Congress, but rather an *ad hoc* system, conceived in pedagogical terms. Each item is classified in three dimensions: *subject matter, pedagogical intervention* and *school grade*. In the CET library, the main *subject matter* headings are: Mathematics, Hebrew, Foreign Languages, Science and Technology, Humanities, Computers and Applications, and Miscellaneous. These headings are further subdivided into a second classification level. The second dimension, *pedagogical intervention*, is divided into two groups. The first one (guided mode) comprises the entries: Tutorial, Testing, Practice, and Coaching, while the second group (free mode) comprises Simulations, Microworlds, Games, Tools, and Programming Languages. These two dimensions are accessible to teachers and students to respectively assign or select programs. The third dimension, which establishes the application range within the curriculum, assigns a range (initial grade/month, final grade/month) to each instructional program. This information is used by the system **pedagogical model.**

CET's courseware and software library today comprises some 700 titles. It is very difficult for a teacher to assign the more appropriate instructional programs individually, according to each student's progress. By the same token, it is very hard for a student to decide on his own what to select. Our solution was to establish a set of labeled pointers, which connect each topic/level pair within the guided courseware with appropriate instructional units, guided or free, within the whole library. This investment expands considerably the possibilities of the pedagogical model. For instance, if a student is experiencing difficulties while practicing a certain subtopic (detected by a lack of expected progress), the pedagogical model may suggest to the student to study a certain tutorial unit; when a certain level is reached, the pedagogical model may suggest playing a certain instructional game, which may reinforce the concepts being studied, or to run a simulation to develop a more concrete grasp of the reality being studied. In fact, the benefit is felt by the student starting from the selection stage, because there are two *menu* options: a) open access to all the library items, and b) selected menu, which includes only the teacher and pedagogical model recommendations. A student who could be disoriented when confronted with all the possibilities in the library may confidently select menu option b, and work with instructional materials individually selected for him.

## 7. A VIEW OF THE FUTURE

We feel that the system presented is a first step in the direction of future educational management systems, where the combination of rich student models with well-defined libraries of instructional materials (including the prerequisite relations among them) will allow for an individually tailored definition of each student's instructional path, while also allowing for the dynamic assignment of tasks to groups of students whose cognitive trajectories are compatible at a given moment in time. This system would allow for the optimal development of the cognitive and social capabilities of all the students, while avoiding the pitfalls of rigid classification schema, which ignore the students' needs in order to protect the inertia of present educational systems. Under the false pretense of defending an unreal "equality" between children, the present system is hurting both the more able and the less able students, and the crisis of educational systems all over the world should be enough to make us reconsider what we have been doing to children.

As Einstein said: "The level of thinking that got us into this mess is not the level of thinking that will get us out."

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# 29

# Education Management - Information Technology and School Autonomy

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**Abstract**

The educational system in Israel, like in some other societies is now in the midst of a decentralization process. An integral aspect of this process is to transform schools into autonomously managed units. Information technology is applied heavily to assist this development in a very similar way to processes in the economic sector.

Keyword Codes: K.4.1; K.4.2; K.4.3
Keywords: Public Policy Issues, Social Issues, Organizational Impacts.

## 1. FOREWORD

This conference's topic is Information Technology in Educational Management. In my presentation I wish to refer also to some educational aspects and not to limit myself only to managerial aspects.

I.T. is developing into one of the main effective instruments, which influence schools and the way education is employed. I believe that due to these new technological options available, organizational, pedagogical as well as managerial changes are to be expected. Never before was the I.T. so directly involved into school's daily work as well as with its optional changes.

## 2. WHY TO CHANGE

In a sense education is knowledge transferring from old generations to young ones, from those who know a thing or two, to those who want to learn. Many reasons accumulate at present, so that there is a tremendous need to redefine school, education, socialization and their content in society [1,2,3,4]

In the last two decades ever more changes are introduced into the educational systems. Some of the reasons for this are the overwhelming criticism and a deep sense of disappointment with public standard educuation, as it failed to achieve main social goals like social integration and equality of opportunities on the one hand, excellence and higher quality of life on the other hand.

As this criticism is becoming widespread and articulate, some of the basic concepts of the educational systems are being put to the test. Two phenomena are always mentioned as the underlying causes. One is the impact of technology on society. Technology upset the well established devide between old and new, between experienced and unexperienced.

Together with the growing impact of the technological infrastructure is the penetration of what is called Neo-modernisme and relativisme which are major factors leading to obscurity and lack of agreement on standard criteria as what one has to study, what is a scientific discipline, what is the conventional target of education, etc. [5,6]

A generation in technology is narrowed nowadays in many cases to only about 4-5 years. New products are almost immediately obsolete as soon as they are released to the public. Developers are always going in new directions towards new products. The effects of this trend are so profound, that in many social areas, change becomes the rule rather than the exception. In many cases we don't have to explain why we need to change, on the contrary we must apologize for routine. Within the educational system the requirement for change has become the fashion, the beleive in the benefits of change has become norm. In the last 15-20 years all Western educational systems have adjusted to new methods, to new concepts, to different teacher/student relationships and have practiced major reforms. Still we sense that the gap between technological time and between the concept of time built in education is widening to such a magnitude that it may threaten the capacity of schools to function as a socialization mechanism. [7,8,9].

The schools mission is to be a preparation for the future with postponing of rewards and satisfaction. During the school years the young generation is gradually socialized to be ready for the day they will replace the adults. Eductional time is based on concepts such as development, psychologic maturation and moratorium. All these concepts share the same common idea: society is subdivided in young people and adults, those who know better and teach and protect the youngsters untill they become mature and capable of fullfilling adult obligations and duties.

School curricula are designed in the same line. The grown-up experienced generation is transferring knowledge to the "new comers". Information is gradually released by the teachers to the students. Academic and classical paradigms are introduced step by step to the students. Schools provide an eclectic part of knowledge traditionally selected and traditionally instructed.

As a result schools find it harder and harder to practice legitimate authority over students. Technology has opened an omnibus of channels to information to the students as well as to the teachers. In many cases the students have easier access to I.T. The role of the teacher as "owner" of knowledge and know-how and in what quantities to release it, is being reduced. Simultaneously criteria for what is more important to the young generation and what less is loosing consensus. More students and grown-ups alike are seeking relevance rather than substance. As to what is relevant no one has one answer, and what is worthwhile to study at school is being debated.

In this context we are witnessing a diffusion of democratization processes into the area of social services like health and education. In this context democracy means the right to have access to knowledge and information. No more monopoly on truth and knowledge, more influence on what I consume as well as more options to select from, according to my taste and my ideology.

In order to execute more influence on ones neighbourhood, to activate ones individual rights in a more meaningfull way - central power must decrease. This raises the legitimization of clients to define the quality and the nature of the services each citizen is entitled to get. [10].

## 3. SCHOOL ORGANIZATION AND EDUCATION

Most of the planning concerned with the nature of schools in the future takes into account the nature of coming trends and emphasizes the following points:

changing teacher - student relationships due to the change in access to information and knowledge through the spread of technology, and due to the decrease of the teachers authority to confine and to determinate the hierarchy of importance or of relevance.

changing the focus on school education to less information as such as it is available and changing to the capacity of handling big quantities of information of all kind. What is learned becomes an area of negotiation between all concerned parties, such as students, teachers, parents and community representatives. Thus there is a parallel claim on establishing organizational changes as a necessary condition to any reform in school, and as an answer to the individualistic culture domineering our social life at the moment [11,12]. Such changes will promote a decrease in homogeneouty and an increase of autonomous units, each of which is identified with a variant flavour in accordance to location, community interests and beliefs [13,14].

In particular school planners foresee an emerging educational market adjusting to liberal economy principles: much less central control, more individual choice, much more control via the market principle of supply and demand. Thus the individual and the group are often approached as clients of educational services, and have the legitimation to shape the product according to their needs and beliefs [15,16]. In this sense schools imitate and adopt very closely the jargon, structure and behaviour of any other economic organization [17,18]. Terms like input-output, head master as school manager & executive, customer satisfaction, costs and investment are penetrating the school climate emphasizing its organizational form,

Interconnection between school system and and the economic system has spouted an intensive debate ever since.

During the 70ies, this debate accelerated, whereas the function of social allocation of schools becomes clear and sound. Though nobody doubts the need for the economic system to provide a substantive basis for economy as well as a suitable ground for the graduate, many scholars opposed the subordination of education to economy. In particular it was claimed that the school emphasizes criteria which are work oriented: punctuality, ordrer, separation of tasks, being on time, in short passiveness, discipline and corformism (and at large justify capitalistic norms and thus serve the interests of the ruling classes.) [19,20,21,22,23].

A related problem is the concern over marketing and fund raising operations, used in the economic realm [24]. To be an organization in a competitive world means to make use of marketing strategies with all the attached meanings. School can find itself under an economic monopolistic interest rather than 'oldfashioned' scientific standards.

The process of school autonomy and decentralization of the educational system could rely on I.T. in a very sophisticated way. The dilemma between the school as providing some unification experience to all the youngsters in a society and between the school providing individually chosen recipies, can be handled by I.T., leaving sufficient control to the centre, whilst each school and district continue to plan according to their beleives and interests. The possibility of organized control over student achievements, funds, staff etc. releases some opposition to decentralization trends and to loss of unity. (see f.e. the 1988 English reform).

School autonomy and decentralization of the educational system, influence also school organization. Untill now the school organization was a loosely coupled organization. Each class has its own cycle, each teacher was a "king" behind the closed doors, he could negotiate his terms with the students, or choose not to negotiate. [25]. The autonomous school will have to change into a more cohesive unit. A school which is based on his resources rather than tied firmly to a centre, must develop team work. Thus the school becomes more fixedly coupled, with much more interdependency, more meetings are required. The more a school becomes similar to any other workplace - I.T. can be of more use. Teachers can do team work even from a distance in time and place, students can discuss issues with teachers and colleagues, etc..

In this sense one can conceive of I.T. as enabling mechanisms to address various needs of the educational system. The decision of what the school is going to be and how it will be managed can easily be implemented when the I.T. options are taken for granted.

## 4 SOME CONCLUDING REMARKS

I.T. is just in its initial impact stage on education and it is followed by a deep need for educational basic reform. In spite of many futuristic guesses about the 'new' educational system and the new school a lot of uncertainty still exists:

1. how technology, which was developed to serve the full fledged adult population can be adapted to young adults and to small children.
2. will I.T. lead to more or to less control? In which areas will it provide more autonomy and in which areas less?
3. what will be the relative position adult vis-a-vis young in schools?
4. what will be the translation of disciplinary knowledge to relevancy knowledge?
5. what will be the influence of extending the definition of class to further than just a unity in place and time?

To my opinion all these questions and many more are to be addressed not as they come, but according to new social definitions of education and schools.

Because reforms which stay within or emphasize organizational aspects, remain often in this stage without any real contextual benefits. I.T. might contribute to these procedures, but cannot in itself carry out educational reforms. Moreover, subordaining education to technological infrastructure will prevent it from acting as a foundation to critique, to lead to establishing criteria of selection, and to fluidity without any stability. Are we, human beings, prepared/able to live in such circumstances?

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# 30

# The Computer as Decision Making Tool in the Junior High School

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## Abstract

These pages will describe the major role the computer plays nowadays in the pedagogical process, as experienced by us, the staff of the Ben Gurion Junior High School. The computer enables the collection and processing of all relevant data in a 'real time' fashion, thus enabling the continuous screening of the activities of all parties involved: staff, students and management. All problems wheter with the staff, the learning materials, or the students, are instantly identified, and corrective measures taken promptly. In this manner, the quality of management is greatly enhanced and school climate is upgraded.

Keyword Codes: J.1; K.3.1; K.4.3
Keywords: Administrative Data Processing; Computer Uses in Education; Organisational Impacts

## 1. INTRODUCTION

The Ben Gurion Junior High School, Petach-Tikvah caters for students from four feeder schools. It contains a population of about 720 students in twenty form rooms. The pupils come from different vicinities of Petach-Tikvah and from heterogeneous population strata, including the underprivileged, which requires extensive integration. The socio-economic gaps are enormous.

The teaching staff has consciously and conscientiously undertaken the task of coping with the difficulties and to prepare suitable learning material for the different needs of individual students. All learning materials are mapped out so that the core, expansion and enrichment are clearly discernible. The materials are written and edited accordingly. Sections out of text-books are rewritten to accommodate personal needs. Audio-visual equipment, television, V.C.R. cassettes, radio, pictures and computers are incorporated too. Unique class rooms have been established for each individual subject, which all include a center, that contains a complete collection of materials appertaining to the particular subject. This ensuries easy access to material and equipment in a scholastic atmosphere that is both motivating and interesting for the learner.

The management has set easily attainable, clear goals that focus on encouraging high scholastic achievements. The existence of only a few, unequivocal and comprehensible rules and regulations as far as order and discipline are concerned, helps to keep violence at its lowest possible level.

There is a central body of teachers in each subject who conduct the development programs on both the scholastic and methodological levels, as well as giving mutual assistance and support.

The computer as a pedagogical aid is a tool that supplies all the teachers with a device for planning, follow-up, control and evaluation of their pupils' achievements, thus enabling them to make the necessary improvements where and whenever needed.

## 2. FOLLOW UP OF STUDENTS' ACHIEVEMENTS

The teachers feed information concerning test results, quiz results, homework, special assignments and any other important data into the computer, thus enabling the classroom teacher, head of department, educational advisor and administrator to see the achievements of the students at any given time in any given class.

This follow-up gives a precise picture of the student's work, both as an individual and in relation to other students in his class, and also to his own previous achievements. It enables a follow-up of the entire three years that the student attends the school: his difficulties, his progress, and his social and scholastic integration.

The computer also gives the classroom teacher a holistic picture of the position of his class. A subject teacher can compare the achievements of each class with other classes which he teaches, between his subject and other subjects that the student studies, and in comparison with the achievements of his colleagues, teaching parallel to him.

When setting grade level tests (i.e., simultaneous tests for all classes of the same grade examining identical material), the computer can supply invaluable material for finding the pitfalls whether in the teaching method, the study material, the students' ability, or the setup of the classes.

The educational advisor is able to detect the students who have difficulties (and the types of difficulties) and to ensure that they get the appropriate assistance in the subject matter, or if necessary, emotional and psychological assistance.

This inclusive picture can contribute to the decision to change the structure of the classes involved. If there are too many learning problems in one class, on the one hand, or too many brilliant students, on the other extra hours or less hours can be assigned, and the inclusion of a special project, or lessening pressure can be stipulated. The achievements of a class or the identification of its problems will be taken into account when deciding which teachers should be teaching which classes. At the same time, the teacher's personality, teaching style and teaching methods, his approach to weak students, will all be taken into account as well when the subject is up for discussion.

## 3. FOLLOW-UP OF TEACHERS' ACTIVITIES

The information gained from the computer enables management to follow up on each and every teacher's work. Through the information on the students, it is possible to compare teachers teaching the same subject, between colleagues teaching different subjects in the same class, to check a teacher's activities and functioning during a three years' period. All this allows immediate action in resolving pedagogical problems.

The teams meet once a week. Each team can get information from the computer and discuss the results of a test or the achievements (or lack of achievements) attained during the semester and then decide whether to continue with the program, to revise the material that sprouted difficulties or even change the structure of the groups. The lateral information available from the computer is vital in coming to constructive and immediate conclusions.

## 4. FOLLOW-UP OF TEACHING METHODS

The computer can give invaluable assistance in this area too. This is achieved by comparing results of quizzes and tests through calculating their distribution charts. When the goals are clearly defined in advance, the computer can check if the teaching materials in heterogeneous classes have really decreased the amount of failures in the different subjects measured, or whether the inclusion of the computer in the math program has brought about a significant decrease in the number of underachievers in that subject.

## 5. CLASSROOM ORGANIZATION

In the junior high school we remain loyal to the original concept of the reform in education, integration and heterogeneous learning. The classes are made up identically - as far as the number of boys and girls, learning achievements, new immigrants, weak and strong students, and discipline problems are concerned. The computer aids with this too, by organizing the learning groups, stipulating who needs extra tutoring, fitting the learner's program to his needs, and assigning the most suitable teacher to a class. When a computer report is scrutinized at the end of a specified period changes can be made in the class.

The computer data can also be used to decide in transfering students to where they may benefit most.

## 6. IMPROVING SCHOOL CLIMATE

Grades have always been a source of dispute and controversy between students, teachers and parents. Lines of parents waiting to speak to a teacher, continuing late into the night, usually end in dissatisfaction and tension. In order to correct this, uniform criteria for grades have been set up. The "value" of an examination, a quiz, homework, lesson participation and a special assignment is always the same in a given subject, independent of who the teacher is. The criteria are clearly formulated, printed out and distributed to teachers, students and parents.

On parents-day, each parent is presented with a page of information carrying the results of examinations, quizzes, homework assignments, and personal remarks. This prevents the student from concealing information about certain results from the parents, and arguments with teachers completely disappear. The computer also compels teachers to take into account all pertinent factors to the student's activity at school.

The constant follow-up of the students' results, raises the teachers' awareness to the need to find solutions for weak students, to develop subject classrooms in which all the diverse learning material is amassed, to motivate all students of all levels - including the weaker ones, to make progress. The constant follow-up of the students' results, raises the teachers' awareness to the need to find solutions for weak students, to develop subject classrooms in which all the diverse learning material is amassed, to motivate all students of all levels - including the weaker ones, to make progress.

## 7. TIME SAVER FOR THE TEACHER

The Ben Gurion Junior High School deals with may different projects that cover all classes and groups of students over and above the usual learning curriculum.

Subjects like the Israel Studies, Technology and Industry in Our Times, Environmental Studies, Learning Styles in the Heterogeneous Classroom and The Incorporation of Multi-media and the Computer in the Teaching Process are the main projects undertaken by our school. Enrichment in Biology, Drama, Dance and Sports are getting priority. Ben Gurion is also a community school, very active in the neighborhood.

All this means, that the teachers are overloaded both time-wise and work-wise. As a result, management must do its utmost to spare as much as possible of the teachers' time. This goal is achieved by inviting the teachers as little as possible to school meetings and by reducing other administrative chores. The services of the computer in this area are also invaluable. At meetings, lists of grades, charts and other documents are distributed to the participants who can then evaluate the status of each student and take corrective measures, both quickly and effectively. The number of participants in these meetings has also been reduced to the minimum: only the class-teacher, the educational advisor, the department head and the management representative are present.

## 8. ASSISTANCE IN HANDLING ABSENTEEISM AND LATE COMERS

The computer is used in order to handle the data regarding absentees, late-comers and disturbers. The teachers, who are relieved in this manner from the tedious toils of handling the data, are free from now on, to deal with the real problems behind it. They can discuss with the students, the parents the school-advisor and if need arises, they can obtain in difficult cases also support from management .

The students are also aware that the information about their misconduct is piling up in the computer and will be expressed in their report-cards. There is no way to erase the evidence or to change previous conclusions and decisions.

## 9. COMPUTER PRINTING OF REPORT CARDS

This has made the class teacher's role easier, not only insofar as he does no longer have to write out the report cards by hand, which took hours, but also by no longer having to tap the necessary information about grades from the various subject teachers. Many times also corrections were to be made. Then, calculations had also to be remade and the incorrect results substituted. Today the responsibility falls entirely on the subject teachers who enter the marks to the computer and verify them. But this task is also greatly alleviated by the use of optical sensing equipment.

On the other hand, management's control over the ongoing activity is greatly simplified, by the use of various analytical methods, which can easily discern the current status of reporting. In addition, incorrect and incomplete information can be easily uncovered by the students, and to avoid inconvenient clashes with them, the teachers must do their utmost in order to make everything as correct and complete as can be. In this manner, one of the major sources of tension between teachers and students has been obliterated and a pleasant and correct atmosphere has prevailed.

## 10. CONCLUSION

The computer has succeeded in a short span of time to become the major aid in the pedagogical process. This achievement is the outcome of its capability in both storing and processing vast quantities of data, as well as in making complex decisions while reacting in 'real time'.

Raising awareness to existing learning difficulties or achievements, discerning social maladjustment and learning difficulties of students, uncovering malfunctioning staff members, managing disclipinary routines and geting a holistic and clear picture of the status of all major issues, has never been attainable to such an extent, before the nt of the computer.

Moreover we must mention that all this is accomplished easily and promptly (in 'real-time'), which enables management to take corrective measures at the right time.

Lastly, the existence and accessibility of unambiguous and verifiable data has also contributed extensively to the reduction of conflict among all the parties involved: management, teachers, students, and parents.

# 31

# Educational resource management with a human interface

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## Abstract

In this paper, one example of designing schedules with a software package is descriped. The software is used to manage all the resources involved in scheduling. This application differs from other similar packages in that it assists the human mind in drawing up the best possible timetables rather than using any algorithm to automatically schedule the lessons.

Keyword Codes: J.1
Keywords: Adminstrative Data Processing

## 1. BACKGROUND

The Helsinki Business Polytechnic represents a new type of educational institution in Finland. The Polytechnic was founded and authorized by the Finnish Government in 1991. The institution amalgamates three colleges: The Finnish Business College, The Helsinki Secreterial College and The Institute of Information Technology (ATK-instituutti).

The Institute of Information Technology (IIT) was founded in 1970. It is a college which specializes in information technology and is owned and sponsored by the IIT Support Association. The Institute's main objective is to advance and develop the practical use of information technology by offering basic, advanced, and supplementary study programs. The Institute is also concerned with the development of education and teaching methods and is involved in research work in the fields of systems development and in the use of computers as tools in various work areas.

Today the IIT offers four different degree programs:

-The Degree Program in Information Technology consists of 140 credit units and covers a period of 3.5 years.
- The Datanomi Diploma Examination for adults in part-time attendance consists of 80 credit units and covers for a period of four years while students work in full-time employment.
- The 20 credit unit postgraduate program for DP professionals.
- The 20 credit unit postgraduate program for business college graduates.

Scheduling a term is a matter of allocating

- four degree program which will include 17 study groups with 6,000 contact lessons;
- 500 students;
- 35 full-time teachers and some 35 part-time teachers, and
- 13 class-rooms, 7 computer laboratories, 11 project rooms and 2 auditoria.

## 2. SCHEDULING - THE PROCESS

The curricula of our four degree programs are divided into teaching terms. Each term is 20 weeks long and is planned as a total unit.

### 2.1 The question of courses

The scheduling begins with students planning their individual study programs for the coming term. They choose both the compulsory and optional courses from a "basket" of courses by filling in a form. The student office counts the number of participants in each course and delivers the information to the management.

The management decides which courses to give according to the level of interest shown by the students. At this point we know the number of lessons for the coming 1994 autumn term: they will amount to 6 000 tutor-student contact hours.

### 2.2. Staff numbers

The teachers plan their individual teaching load for the following term. This may be reduced for individual research and development work in their own field of teaching. The load may therefore vary from term to term.

The teachers in Information Technology usually teach at most 304 lessons per term (an average of 16 lessons a week of which 8 are contact hours). If they participate in development projects the number of lessons can be anything between 0-304. Teachers in General Studies, Business and Economics usually teach from 361 hours (19 hours per week) up to 450 lessons a term. On average, we need 33 teachers for 12 000 lessons; but in practice there are 35 full-time teachers and over 30 part-time teachers.

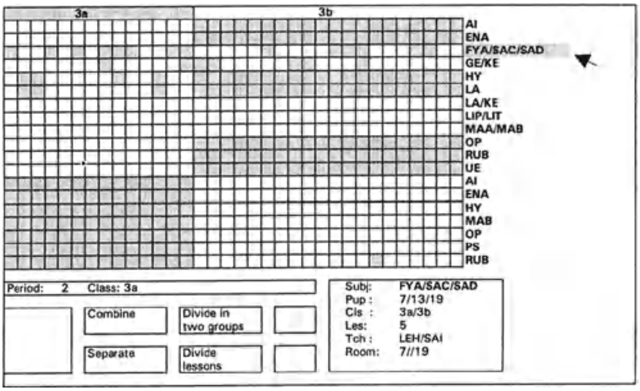
### 2.3 Preparing timetables

The students register for both compulsory and free-choice courses. This is done by means of a school administration software program called *Primus* made by a Finnish company called *StarSoft Ky*. *Primus* keeps a record of the information concerning individual students' names and addresses, course selections and credits. It also includes all the information about the curricula, the subjects and their credit units. All this information is transferred to *StarSoft Kurre* which is used to design the timetables.

### 2.4 Planning the study groups

The students are divided into study groups (classes) according to their choices. This is done with *Kurre*, which assists in finding all the students that have the same combination of selections. They can then be formed into a study group or, if there are too many students, divide them into smaller groups which have all made the same selections. This procedure is iterative and is continued until a satisfactory result is reached. The idea is to create groups that are as independent as possible.

In figure 1 we see the grouping screen. There is a column for each student and a row for each subject. A white square means that the students have chosen the subject in question. Students are grouped by moving them from one class to another or by linking two or more classes together in one subject. Within a class the goal is to obtain white areas that are large as possible. In figure 1 the cursor is pointing at the third row, which shows three linked subjects: FYA/SAC/SAD. More details of the subjects are given on the lower right of the screen. There are 7/13/19 students studying those subjects and they are currently in classes 3a and 3b. Each subject has five lessons a week and these can be taught at the same time because only one student is attending any one of the linked subjects. The detail screen also shows the teachers and class-rooms accordingly. In this example the second subject has as yet neither teacher nor room.



Period: 2 Class: 3a

Subj: FYA/SAC/SAD
Pup : 7/13/19
Cls : 3a/3b
Les: 5
Tch : LEH/SAI
Room: 7//19

Figure 1. Grouping students according to their selections.

### 2.5 Planning the periods

The term of the Degree Programme in IT is divided into two periods. In this phase subjects are placed within the required period. It is also possible to change a subject from one period to another, thus, for instance, providing more evenly spread schedules for teachers.

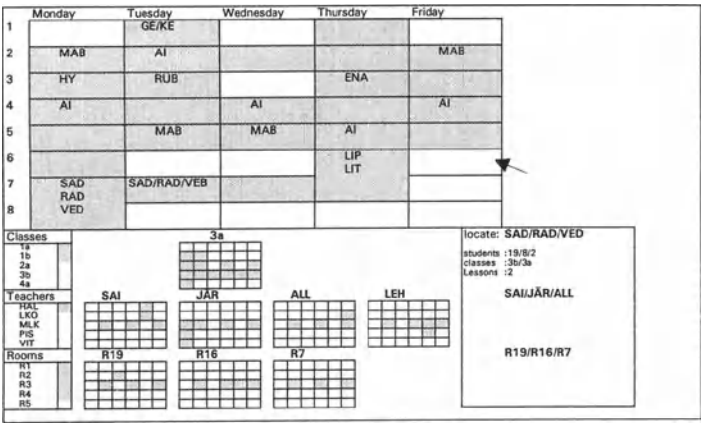
### 2.6 Planning the timetable

Then comes the most challenging work: To place every 2-8 lesson block of four different degree programs on one week's timetable and to optimize the situation from any point of view. The primary goal is to give students a chance to study what they choose, to avoid empty hours in the middle of the students' day, to optimize the use of computer laboratories and other classrooms, to fullfil most of the teachers' wishes in planning the timetable. Everyone who is in charge of making timetables knows that these demands need small or sometimes even big miracles to come true. These miracles are performed with *StarSoft Kurre*. It does not automatically schedule the lessons according to any algorithm. Its main purpose is to support the human mind in making good timetables by keeping a record of the situation and preventing errors.

Arranging class schedules with *StarSoft Kurre* is easy and intuitive. The program instantly checks all the possible slots for a lesson and shows them clearly with a special color. Even if the lesson in question affects several classes and teachers, the screen at the time of placement shows miniature schedules for all parallel classes and for teachers involved with the lesson. Whenever the need arises, you can look at your school's overall situation in miniature on the screen. Every small detail can be enlarged to full size for closer inspection. The situtation can also be examined from three possible perspectives: the study group's, the classroom's and that of teacher availability. The decision to place a lesson is always made by the user. Human factors, too, can be taken into account in drawing up the best possible timetable.

Figure 2 shows a screen of arrangement. The problem at hand is to locate an object of three subjects for two classes and three teachers. The restrictions are that not all the teachers are available, students are occupied with some other subject, or, there is no class-room vacant. These restrictions are marked red (lighter gray in the figure 2). The program allows the user to put this object on any of the white rectangular slots. In the bottom half of the screen, a miniature schedule of the other class is shown which includes the three teachers and three classrooms involved. The miniature schedule of the fourth teacher (LEH) is chosen by the user.

In the bottom left corner there are lists of classes, teachers and rooms. Any of them can be selected to obtain a miniature update of the current schedule in order to gain a wider overview.



|  | Monday | Tuesday | Wednesday | Thursday | Friday |
|---|---|---|---|---|---|
| 1 |  | GE/KE |  |  |  |
| 2 | MAB | AI |  |  | MAB |
| 3 | HY | RUB |  | ENA |  |
| 4 | AI |  | AI |  | AI |
| 5 |  | MAB | MAB | AI |  |
| 6 |  |  |  | LIP<br>LIT |  |
| 7 | SAD<br>RAD<br>VED | SAD/RAD/VEB |  |  |  |
| 8 |  |  |  |  |  |

locate: SAD/RAD/VED
students :19/8/2
classes :3b/3a
Lessons :2
SAI/JÄR/ALL
R19/R16/R7

Figure 2. Arrangement of the lessons.

The program also has an autochoice function which can choose at any moment the most difficult lesson left to place in the schedule. Used frequently enough, autochoice ensures that lessons which are difficult to place are taken care of early on, thus reducing the chances of getting into a dead end situation.

In practice, I first mark so-called 'reserved times': Teachers may have commitments that prevent them from giving lessons at a certain time of the day or week. On the other hand, some part-time teachers and experts want to give their lessons at a certain time. I locate these lessons first.

The lessons can be placed by class, by teacher or by room. I usually start locating with the computer laboratories because they are the most wanted. After that I place teachers with greater time restrictions and then I place the lessons class by class. All through this the program supports me by showing the situation from any point of view and helps me to plan high quality schedules.

In the middle of arranging, the editor function in the arrangement program allows to change the input data, change subject labels and teacher and room designations, enter new information or remove old information, and so forth. All the necessary changes can be made as soon as the need to change appears.

### 2.6 Printing the timetables

The printing functions are very flexible. Already at the input stage data can be printed out for proof reading. The class schedules can be printed out at any time in whatever form chosen. With the help of the program the format of the printout is easily specified to conform to users' needs. The program can store many different printing and printer specifications.

For payroll calculation, a list of all lessons can easily be printed for each teacher. A similar list can also be printed for each class or each room. For daily needs and, for example, for the telephone exchange, tables can be printed which show at a glance the availability of each class, teacher or room.

IIT draws up new schedules every week. Although weeks within one degree program tend to retain the same structure throughout the whole term, the part-time attendance program provide for contact lessons only one week per month; thus we give four different classes in a month and a teacher's timetables for four consecutive weeks may be different. This makes IIT a large-scale consumer of schedules.

After inputting all the lessons, the software prints out individual timetables for

- students (about 500);
- study groups (17 groups in four degree programs);
- teachers (about 70);
- classrooms and computer laboratories (31), and
- course diaries with the names of the attending students.

You can also print information in many condensed forms such as:

- wall tables;
- list of lessons;
- vacant classes;
- non-occupied teachers, and
- vacant class-rooms.

## 3. EVALUATION OF THE SOFTWARE

The *Starsoft Primus* and *Kurre* are specially developed for school administrations. The user interface is sophisticated and is based on graphics. Once having fed in the data, i.e., the names of the students, teachers and class-rooms, and the subjects in all curricula, the user works with the mouse in selecting the required data from lists shown by the program. The user hardly needs the keyboard at all and this feature makes errors less likely. It is also more efficient to point to the required data instead of typing it.

The software is very flexible. When first purchased, it contains the most usual registers in a school administration. The user then defines the rest of the contents of all registers and determines in which order he or she works, thus tailoring the software for optimal use in his or her own environment.

The software is available in any version of IBM or compatibles. It runs under MS-DOS, OS or Windows. *Primus* needs at least an 80286-processor, a 1 Mb RAM, a fast hard disk together with an EGA-screen and a Microsoft-compatible mouse. *Primus* also works in local networks. Complete transfer of information is possible between *Kurre* and *Primus* in both directions.

The producer claims that the software is very flexible and, although I am usually highly sceptical about such claims this one I can endorse. To sum up then: Although I believe that no product is so good that it cannot be made better, *StarSoft Primus* and *Kurre* constitute a product I can go a long way toward recommending. One must not forget that planning quality timetables like these is time consuming. Nevertheless, I think that it is time well spent. Awkward, perhaps unsocial, hours on a student's or teacher's schedule will not do much to maintain or improve learning or educational standards.

PART SIX

# Panels and Discussions – Summaries

# 32

## ITEM in Educational Systems: Where are we? Where are we going?

Panel Discussion

Chair: A. J. Visscher

Panelists: C. Fulmer, A. Fung, Y. Gev, P. Nolan, I. Selwood, A. Tatnall

The first topic discussed was the strategies for designing computer-assisted school information systems (SISs).

It was suggested that schools should prepare students for the world of tomorrow and therefore software designers should design SISs for the administration and management of the schools of the future. Designs should be directed at problem solving rather than adapting to what already exists and school staff must be involved in design activities. One way of meeting this need is for groups of school administrators to be formed to determine the information needs of schools.

Countries that had worked more in a "top-down" way (experts imposing a system upon schools) had experienced negative results (e.g. resistance from school staff). However, a certain degree of this "top-down" approach may be desirable since school staff do not necessarily know of all the possibilities that it can offer and therefore may adapt to the existing situation too much. The "expert" must point out to schools new and valuable computer assisted activities, as they become possible, so that school functioning can improve. Following this, schools need to determine whether these innovations should be adopted, adapted or rejected. The feedback of users is crucial and one way of ensuring this, that is also a prerequisite for success, is to form user-groups (to receive proposals for software design and adaptations). A hot line for direct contact and conversation between schools and software producers is also a necessity. However, systems must be developed in an incremental manner and therefore user feedback can not always be implemented immediately as this could lead to systems that are hard to maintain (software - spaghetti structures).

A number of other problems were observed in the existing situation, including:

* Lack of awareness, on the part of users, that information needs must be assessed periodically.

* A monopoly of one software vendor in a country is undesirable (no drive to optimize the software).

* Schools have found it difficult to evaluate available systems, and are also in need of training and advice on a variety of matters, including security arrangements.

* Links between management systems and pedagogical computer applications are needed.

* The impact of ITEM on the teacher-learning process must be at the center of attention (supporting teachers by means of ITEM should be an important goal).

We should first think about what we would like schools to be and then determine how ITEM can help us in achieving that goal (ITEM as a means and not as an end).

It was also suggested that there was a need for more research and publications concerning ITEM in general, and more specifically , a need for objective evaluations of software packages, but in many cases it is difficult to find the required funding for such activities.

One of the panelists stated that we are still behind in ITEM if we compare educational management uses of IT with other IT uses in society. ITEM has not raised productivity of schools yet and is still feared by many teachers and principals! It was re-stressed that, we should avoid a "we" (ITEM designers and promoters) "them" (principals and teachers) approach and that a dialogue should exist between researchers, developers and users in schools to avoid repeating mistakes.

Another important goal should be realizing communications between schools (even between schools of different countries), external data banks, and external organizations (educational and other) to enhance knowledge about ITEM and data communication.

Hong Kong in line with the above approach is working on developing teacher support systems that link teachers and experts in order to support classroom teachers with information concerning content and methodology of subjects. Israel is also trying to support the work of classroom teachers directly under their ITEM initiative by providing them with software tools for assessing pupils.

The general conclusion that was drawn for the panel discussion was that - "throughout the world there appears to be a lot of similarity in experiences, problems and needs, and therefore better ways of exchanging information across the world are desirable".

# 33

# Introduction of IT in School Management: Approaches, Preparation, Human and Political Aspects

Discussion chaired by:

Ian Selwood[a], Phil Wild[b], Daniel Millin[c]

[a]The University of Birmingham, School of Education, Edgbaston, Birmingham, B15 2TT, UK
[b]Education Department, Loughborough University, Loughborough, LE11 3TU, UK
[c]School of Education, Tel Aviv University, Tel Aviv, Israel

## INTRODUCTION

The discussion group was asked to review the introduction of information technology into school management and administration from the viewpoint of approaches, preparation, human and political factors. The group met on two separate occasions. The first session was a general round table debate that centred on the distinction between the administrative and management functions of ITEM systems in use around the world, and also considered why management functions had not developed at the same rate as administrative functions. The second session was more directly focused on issues concerned with the assimilation of IT into school administration and management.

The report endeavours to summarise the wide ranging debate of the first session and details the points made in the more focused discussion of the second day.

## SESSION 1

There was a general consensus that the political agenda can influence developments. IT implementation can become very intermingled with devolution of powers to schools, as in the UK and Australia. Accountability must be part of devolution and IT can help to provide the authorities with the information that they require but, systems developed in schools do not necessarily provide for this interchange of information. Systems must therefore be specified by the authorities and this can lead to 'big brother' anxieties. It was agreed that, whilst many schools throughout the world were using IT for administration, management uses were limited. Reasons suggested for this were:

- School managers might find computers threatening.
- Many systems concentrate on administration functions and do not provide for the necessary linkage into the management decision making of the institution.
- Administrative tasks were often separated on the IT based system even though in manual systems they overlap.
- Personal interests of staff might predominate over implementation of wider access to information.
- A lack of understanding of the management of change required to assimilate IT means that there is no overall strategy for IT utilisation.

- School managers may not have been trained in using the information provided by ITEM systems to support their management decisions.
- It was suggested that research has shown that managers do not like making decisions on aggregated data but prefer to use intuition. They often feel that they have to react quickly without having the time needed to make use of the available information and fully consider the options.
- Accountability has lead to more 'management by committee' which might reduce the direct use of IT for decision making and planning.
- In many cases the introduction of ITEM is at the instigation of LEAs or Governments and change introduced by external agencies without adequate consultation does not work.

It was suggested that the use of IT for administration rather than management was a necessary first step to introducing the use of ITEM and that assimilation of any new system takes time. The benefits of using IT in Administration are more immediately tangible than those of management decisions based on the IT. This accounts for the more ready acceptance of administrative IT. However, this identified value of administrative IT needs to be extended into management functions. Other suggestions for overcoming resistance to change included:

- Assimilation needs to be carefully planned into the organisation
- New software should have functions more clearly identified as support for decision making
- Information provided by the software should link to identified management goals.
- An enlightened member of staff with vision can promote wider use.
- A realisation by managers that information systems might help to provide better quality time to use management data.
- A need for training to change the present mode of decision making.
- Technological training must go alongside management training.
- For successful assimilation of ITEM a positive attitude towards IT needs to be engendered in all staff through the use of IT as a personal productivity tool.

Reservations were expressed concerning the possible misuse of raw statistical data in educational decision making and IT based information could be used to compare pupils, teachers and schools in an inappropriate manner, further reinforcing 'big brother' fears. Information systems should be used to help inform, but educational decisions should be based on human judgement. 'Educational Atmosphere' cannot be computerised.

## SESSION 2

Having considered the problems of the assimilation of ITEM the group felt that we should adopt a different approach in the second session and try to produce some guide-lines for its introduction, the preferred starting point being an examination of the goals of ITEM.

## GOALS

The following goals for the introduction of IT into Educational Administration and Management were identified during the discussion:

- To increase the efficiency and effectiveness of the educational institution in order to provide a better service for all students.

- To relieve teachers, management and support staff from mundane administrative tasks.
- To collect and provide accurate and up-to-date information in order to aid the planning and administration of the educational institution.
- To meet the increased requirements for reporting and accountability.
- To improve the manipulation and presentation of information for different audiences.
- To aid in the evaluation of students, teachers and schools within the limitations of the data and moderated by educational considerations.
- To automatically provide details of exceptional situations for management decisions.

## APPROACHES AND PREPARATION

The following general headings were identified and are presented here as broad guide-lines. It was noted that this was not a linear and one off procedure but a continuous cyclical process, and the stages conceal very complex processes in which educational institutions could and possibly should use outside assistance.

1. Identify users.
2. Together with the users, review current and previous practice within the institution and the wider IT community.
3. Provide phased training relevant to the function of users.
4. Explain potential benefits to all staff.
5. Phase introduction (or extension of use) of ITEM application by application to ensure immediate rewards from use.

## CONCLUSION

The above identifies many issues relating to the introduction of ITEM in schools. Factors that inhibit assimilation were discussed at length and are listed, as are many of the major suggestions made for overcoming resistance to change. It was also strongly felt, that in order to evaluate the effectiveness of ITEM there was a need for goals to be set prior to any change, and that adequate preparation for introducing or changing systems could not be over stressed.

# 34

## ITEM as a Catalyst for School Reform

Discussion chaired by:

Patrick Nolan[a], Arthur Tatnall[b]

[a]Massey University, New Zealand
[b]Victoria University of Technology, Australia

## 1 INTRODUCTION

The topic for discussion, ITEM as a catalyst of school reform, was addressed using a structured workshop technique: (i) initial "brainstorming" by the whole group to establish a modus operandi and agree on objectives and procedures; (ii) heterogeneous task groups to carry out the work; and (iii) reporting back which included discussion and agreement on the form and content of the report.

The brainstorming session identified two broad perspectives within which the participants elected to discuss the topic: (i) a Minimalist perspective; and (ii) a Maximalist perspective. Groups were formed corresponding with this distinction. The task for each group was to produce a report on the topic under five headings:

1. An overall summary;
2. School reform - meaning, focus/scope, task;
3. The meaning of ITEM as catalyst, e.g. stimulus, cause, result;
4. The meaning and scope of ITEM (what it includes/excludes); and
5. Issues and challenges to be addressed and resolved.

Although Pat Nolan and Arthur Tatnall acted as group leaders and editors, the final report is the collective product of all the group members listed below:

Ben Zion Barta (Israel), Rory Butler (New Zealand), Rosario Berriel (Spain), Helene Dimmitt (Australia), Connie Fulmer (USA), Yaffa Gev (Israel), Rami Hazarchi (Israel), Tsurayuki Kado (Japan), Porya Kalai (Israel),Pat Nolan (New Zealand), Luis Osin (Israel), Javier Osorio (Spain), Jorge Rodriguez (Spain), Israelit Rubinstein (Israel), Ilana Sagi (Israel) Yaacov Sapir (Israel), Arthur Tatnall (Australia), Ray Taylor (USA), Moshe Telem (Israel), Adrie Visscher (Netherlands).

The contents are presented under the two headings of Minimalist and Maximilist, with summary comments given at the end in the conclusion.

## 2 MINIMALIST PERSPECTIVE

The term Minimalist is used to indicate a limitation on the least that it was thought could be meaningfully addressed within the given topic, at least initially. In other words, this group took the view that the domain to which ITEM can be sensibly applied does not encompass all educational topics.

**Overall summary**

The Minimalist group made three summary points. Firstly, ITEM challenges educational professionals (school administrators and teachers alike) and researchers to confront and actively deal with the inevitability of change associated with information technology developments affecting education. Secondly, ITEM is not a panacea for solving the persistent problems and issues of education. Thus, a healthy skepticism is required to properly assess the likely costs and benefits of applying information technology to, and within, education generally and educational management in particular. This point reiterates the counsel of caution made by Dr Gershon Metzger in his opening address. Thirdly, given the complexity of educational institutions, there is a need to know much more about how to make design and implementation strategies work effectively in educational contexts.

**School reform**

Within the Minimalist perspective, school reform is taken to mean change for the better (i.e. the task). Reform, thus defined, is sometimes interpreted as improving efficiency and/or effectiveness.

The scope of reform is such that it may occur at any school level or with regard to any school function. It may involve: (i) more efficient and equitable allocation of resources in regard to classes, contact hours, educational materials and the ratio of teachers to pupils; (ii) changing the relationship between teachers, administrators and principals (e.g. away from top-down authoritarian practice to bottom-up collaborative practices), and (iii) changes in classroom processes and teacher-student relationships which may affect traditional teacher role definitions, authority and status.

**The meaning of ITEM**

ITEM includes information processing systems and tools to fulfill optimal pre-conditions for the learning and teaching process. The definition excludes the use of information technology in the actual process of delivering learning and teaching. In this sense, ITEM is essentially a means to an end, not an end in itself.

**ITEM as a catalyst**

ITEM as a catalyst may, depending on circumstances, serve as a stimulus, a cause and an outcome of an externally imposed decision. For example, a regional educational authority may decree that schools employ information technology to meet accountability requirements. Thus used, however, it may stimulate other uses that meet a school's internal administrative needs.

**Issues and challenges**

Given the conservative nature of schools and teachers lack of experience with information technology, overcoming teachers' and school administrators' fear of information technology will be a major challenge, requiring sustained professional development and support programmes into the foreseeable future.

Educational institutions such as schools have characteristics which distinguish them from other kinds of institutions, e.g. a bank or a manufacturing business. A task, not to be underestimated in its complexity, is that of designing ITEM systems with characteristics (and capabilities) which match the organisational, administrative and managerial characteristics of schools.

The society which schools are intended to serve is changing rapidly, and will continue to do so, into the foreseeable future. If schools are to educate students for that society they too must continue to develop and change. Theorising about and developing schools that will meet the educational needs of children in the society of today and tomorrow is a matter of top priority. A challenge is to design ITEM systems that support and enhance the primary objectives of such schools.

## 3 THE MAXIMALIST PERSPECTIVE

This group took the view that information technology in general, and ITEM (broadly defined), had the potential to produce fundamental changes in all aspects of the school system. For instance, it has the potential to democratise school admininistration by making key information more freely and widly available to all school personnel. It was stressed that the purpose of educational management at any level is to create the conditions necessary for effective teaching and learning. Here too, educational management is seen as a means to an end, and not as an end in itself.

**Overall summary**

Information technology is a means which has a huge potential for helping schools manage the process of helping learners reach their individual and interpersonal potentials.

**School reform**

School reform is the process of organising all the subsystems of schools such that they are effective with respect to their objectives - more specifically, that they will enhance learning as a social process while not compromising a concern for the individual.

The focus of school reforms is that all learners (including students, teachers, administrators) have a right to maximise their potential, and that maximisation ought to satisfy society's needs. The scope is any educational system and includes all subsystems.

The task of school reform is to prepare an infrastructure to achieve the above, including ITEM.

**The meaning of ITEM**

ITEM should be thought of as Information Technology for Educational Management, and includes all those subsystems of schools which will yield to information technology - administrative, instructional, student services, etc.

**ITEM as catalyst**

The group felt that a more appropriate term than 'catalyst' would be 'means'. The discussion would then hinge around the concept of ITEM as a 'means' of school reform.

**Issues and challenges**

There is a need to do further work on the word 'means'. The group felt it understates their intended meaning.

Among 'hardware / software / humanware', the latter is the one that is furthest behind.

Hardware and software capable of achieving the task at hand may not yet exist.

## 4 CAVEAT - THE TWO GROUPS

Conversation in the Maximilist group was limited by the need to accommodate some minimalist participants. A similar accommodation was made in the Minimalist group. This left both groups with a perception that views expressed in this document may be even further apart than they appear on the surface.

**Change for the better?**

It was acknowledged that not all change that may be caused by the use of ITEM is change for the better. In one case mentioned, the introduction of ITEM actually frustrated and stifled educational innovation and reform. Hopefully this will not be a common occurrence.

Like the Minimalists, for the purposes of this discussion, school reform was taken to refer only to beneficial change.

## 5 CONCLUSION

As one conference participant put it "we should look to make new kinds of mistakes rather than repeat the mistakes of the past," as we seek to integrate the best that ITEM systems might have to offer with our research and development agendas for educational advancement and reform. In these agendas, the indications are that alternative and new approaches to curricula, learning and teaching are required. Information technology has already demonstrated itself to be a powerful tool for the enhancement of both curricula and learning and in the implementation of the desired alternative and new approaches. While much ingenuity has been shown in designing and using the ITEM systems demonstrated at this conference, more ingenuity still is required to harness ITEM systems in support of the educational goals and objectives of the schools. Perhaps ITEM working conferences of the future might dedicate themselves to the achievement of this end.

## 35

# Pedagogical Decision Making in a Computerized School Environment

Discussion chaired by:

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## 1 INTRODUCTION

### 1.1 Pedagogy

A focus on pedagogical decision making requires, initially, an understanding of what is meant by the term, "pedagogy". Pedagogy might mean, differentially , three different views of the teaching process: first, pedagogy as the process of transferring information or knowledge to another person or entity; second, pedagogy as the art, or science, of teaching; and third, pedagogy as the structure in teaching, or information transfer, which facilitates learning effectiveness and efficiency.

### 1.2 Decision Making

Given our view(s) of the teaching process as simultaneously input (structure), process (transfer), and output (effectiveness and efficiency), decision making in pedagogy identifies three distinct, though interrelated , ends: first, decision making which supports pedagogy needs (viz., to help teachers to teach and to manage the teaching process); second , decision making which promotes awareness of the decision making process (viz. to explain or illustrate the elements and procedures of decision making; and, thereby validate the decisions reached); and third, decision making which assists the decision maker to perform improved decision making in the future (viz., to learn how to make better (more valid and reliable) decisions based upon one's experience of the past).

### 1.3 Decision making by Teachers

Given our examination, thus far, of the notion of pedagogical decision making, we fully recognize that decision making by teachers is largely intuitive at the time such decisions are reached during the conduct of the teaching-learning process; therefor, such intuitiveness is temporal to the classroom environment. Intuitiveness is defined in this context the conscious selection from among multiple alternatives of a single decision, taking into account elements of authority, experience, inductive reasoning, and deductive reasoning. At the same time , we do not discount that pedagogical decision making on the part of teachers is also reflective; e.g., the rethinking of a decision ex post facto in order to refine (improve) decision making as a process, or decisions which may be necessary in similar circumstances, in the future.

### 1.4 The computerized School Environment

As may be evident from the preceding commentary , we choose consciously to include any uses, both actual or potential, of computer technology in the educational setting as foundation for our discussion. Thus, any use of computer technology, whether for direct teaching, supporting indirectly the teaching process, resource management of the instructional environment from a campus wide perspective, or communication is acceptable in our characterization of a computerized school environment.

## 2 NEEDS

### 2.1 Scope

There exist (at least) five global needs which influence any discussion of pedagogical decision making in computerized school environment. Since needs are directly linked to recognized problems in a pre-decision setting, these five needs may be accepted as "problem statements" or goals, to be satisfied. First, highest-level centralized access to computer-resident information (management information system (MIS)) must exist (e.g., to facilitate student record availability and transfer). Second, decentralized access of relevant information to the level of the classroom teacher must exist, as well, (e.g. to assist in decision support system (DSS) usage to support instruction). Third, there must exist high value in, and therefore visible priority for, improvement and innovation at all levels of the educational enterprise (e.g., by teachers, administrators, support services staff, governing boards, and parents).Fourth, there must exist , as well, high value for initiative in decision making at the level of the classroom teacher (e.g., to promote comprehensive decision making by the teacher in meeting the special needs of individual students). Lastly, computerized-based information for decision making must exist in a framework which promotes both predictive and projective inquiry (e.g., to support strategic planning as well as tactical control of the instructional process).

### 2.2 Considerations in Pedagogical Decision Making System Development

Several elements must be considered as a system for pedagogical decision making is conceptualized, developed , implemented, and (then) validated in a computerized school environment. Not necessarily stages or phases, these elements must be recognized and continually reviewed throughout system development. A total of 11 elements are considered essential:

* Gather root data about all symptom problems observed.
* Define specific targets for computerized information intervention as a decision making tool.
* Develop a model which conceptualizes the decision making process.
* Decide what a computer can not do (practical) as well as should not do (ethical).
* Recognize the value of personal experience (inductive reasoning) for guiding system development.
* Asses the validity and reliability of "hand " data before computer entry.
* Standardize the developed system and its associated processes in routine practice.
* Link this decision making system, as a decision support system (DSS), to existing statistical exception system which only alert the user to a probable problem.
* Retain the human element in the use of the system for decision making.
* View the computer as a tool which assists the mechanical provision of information.
* Assess and evaluate continually the progress of system development , from conceptualization (needs assessment) through incorporation (standardization of practice).

# 3 SUMMARY

## 3.1 Responsibilities of schooling

Pedagogical decision making, envisioned in the computerized school environment, must attend to the ultimate aims and responsibilities (viz. mission) of schooling: (1) to teach children; (2) to manage the process of learning; (3) to assess progress; (4) to define new strategies; (5) to satisfy clients; and (6) to provide (for) shared decision making.

## 3.2 Pedagogical Decision Making

Therefore, pedagogical decision making mirrors decision that are required in the areas of curricula, instructional process, individual v. group learning, performance-based results in assessment, and the allocation and distribution of resources to support the needs of instruction. In this vein, we must go beyond the notion of computerized informational access, from preparing exception reports ("Where are we?"), to directing our efforts for problem resolution ("where might we go?"). Only then will education enjoy the true benefits of a computerized data access for decision making.

# 4 RECOMMENDATIONS

The following recommendations were reached through the discussion regarding pedagogical decision making in a computerized school environment.

## 4.1 Recommendation 1

Accept pedagogical decision making as incorporating three facets: supporting pedagogy needs; promoting awareness of the decision process; and, assisting the improvement of decision making in the future.

## 4.2 Recommendation 2

View the classroom teacher as the root of a solution, not the source of the problem.

## 4.3 Recommendation 3

Value inductive reasoning in the formulation of the structure and process of the decision making model.

## 4.4 Recommendation 4

Assure intensive and continuous training throughout the theoretical phases of employee tenure in the educational enterprise: beginning preparation; induction; in service.

## 4.5 Recommendation 5

Facilitate consensus at all levels in the development of decision making system.

## 4.6 Recommendation 6

Insure that the decision making system extends beyond the more traditional management information system or statistical exception system, embracing the true benefits of a decision support system.

### 4.7 Recommendation 7

Institute high-level, centralized integration of all academic and administrative computing decision systems, coupled with high-level, decentralized access and utilization.

### 4.8 Recommendation 8

Monitor the formulation, execution, and utilization of the decision system for continuous reflection, refinement, and improvement.

### 4.9 Recommendation 9

Maintain a philosophy that effective schooling is a shared responsibility, required shared decision making as well as shared values.

### 4.10 Recommendation 10

Remember that the preceding nine recommendations reflect our responsibilities to children and their learning; not our need for image or to innovate.

# 36

## Telecommunications in Educational Administration and Management of Learning in Higher Education

Discussion chaired by:

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## 1. INTRODUCTION

In discussing telecommunications in ITEM, there needed to be a distinction made between
- management of the delivery of education e.g. distance education, open learning
- management of the infrastructure in educational administration.

What managers can do evidently depends on the infrastructure provided in their home country or region. Clearly the infrastructure is no well provided for in many parts of the world or in some areas of education. What managers can do also depends on the susceptibility of users to the technology. Earlier in the conference, we were provided with an example of where technology failed in past because the modems supplied to teachers had been stuck in cupboards and whereas ITEM had succeeded within the schools, there had not been interaction through telecommunications with the outside world.

## 2. DISTANCE EDUCATION

This has become of vital importance to many countries, especially those with geographic problems such as Australia, to enable access to learning by students in remote regions who otherwise would be denied educational facilities.

In using information technology and telecommunications in distance education, the discussion group did not find E-mail to be a satisfactory solution in teacher - student communications, because:
- in many countries it was expensive.
- it was a slow and ineffective way to communicate.
- it did not permit simultaneous interaction for successful use of telecommunications in distance education, major issues identified included;
- The need for students to interact with one another must be accounted for; technology that provided for teacher student interaction only was less than ideal
- teachers of distance education need far different skills (both in teaching and in information technology) to the skills appropriate in the conventional class room.

It was agreed that distance education required an integrated, interactive process. Teaching and learning by distance needed to provide for the teacher and the student the ability to hear, view and interact on a computer simultaneously. It was not evident to the discussion group whether such interactive systems were readily or widely available, if at all, in many countries, particularly in the secondary education sector, nor, if it was, whether it was financially viable.

In the higher education sector, in some countries at least, these systems were currently available, giving students and teachers simultaneous access to computer files and the ability to change files whilst talking at the same time.

An alternative technology, and one perhaps less costly, was the use of interactive video with random digitized access. This technology is known as interactive Multi Media TV Access and is used successfully in the USA and Australia. Students could be provided with the pre-recorded video by mail or record at home on a special bandwidth which does not interfere with normal FM bandwidths or it could be downloaded computer to computer.

It was questioned whether these systems are really effective in the learning process.

It was agreed that much more research-needed to be done on this issue. The general consensus, however, was that the enhancement of distance learning through ITEM and telecommunications was a significant improvement to the earlier paper-based methods and had brought education to many students who otherwise would be denied it.

The fact that there is a higher drop-out rate of distance education students did not necessarily imply that the technologies employed were at fault - there are so many factors that cause students to drop-out regardless of whether the learning medium was paper-based or through telecommunications. Distance education students, for example, required much greater motivation and discipline and invariably were in full or part-time employment and/or raising families.

## 3. MANAGEMENT OF INFRASTRUCTURE IN EDUCATIONAL ADMINISTRATION

In this area, it was agreed that e-mail had become an essential tool to managers in communicating effectively and efficiently, within their country and region and most importantly for managers in higher education, to institutions and individuals overseas.

Another important innovation using telecommunications was interactive voice response systems (IVRS), which has been highly successful in higher education in the USA and Canada and more recently in Australia.

IVR Systems provide many benefits, such as:

- the perfect solution to the old problem of peak loads in tertiary administration , e.g. in enrollments, admissions etc.
- students obtain instant feedback and information, e.g. on subject/course availability.
- students update the database themselves, therefore data entry by administrators is not necessary.
- the data is correct - the system will not permit wrong course codes, invalid data.
- students need only a telephone to use IVRS. They can therefore interact with the university database from anywhere in the world, at any time of the day or night. it is convenient and relatively inexpensive.
- experience in the USA has shown that if syllabi/course information is also available on-line, it can reduce changes to enrollment by up to 85%.
- IVRS technology is very simple to understand and to use. In fact students today prefer to use IVRS than the old paper enrollment systems.

## CONCLUSION

In higher education, the use of telecommunications in IT has had enormous benefits to universities and to students, both in management and in teaching. To build on these benefits, attention must be given to the different training and skills needed for teachers in distance education as opposed to those in the classroom. This also needs to be supported by appropriate research.

# INDEX OF CONTRIBUTORS

Barta, B.-Z. 9
Berriel, R. 139
Bruno, J.E. 179
Burton, G. 117

Chen, D. 147

Dimmit, H. 122

Feinmesser, A. 79
Fulmer, C.L. 3, 233
Fung, A.C.W. 37, 233

Gev, Y. 46, 79, 233

Hsu, S.H. 50

Juliff, P. 128, 246

Kado, T. 187
Kalay, P. 147
Katz, Y.J. 195
Komiya, S. 187
Kuhlmann, G. 50

McClelland, A. 134, 246
Millin, D. 235

Netz, N. 201
Nohejlová, A. 109
Nolan, C.J.P. 63, 233, 238

Offir, B. 195
Osorio, J. 139
Osin, L. 209

Paturi, T. 225

Rodríguez, J. 139
Rubinstein, I. 215

Sagi, I. 79
Selwood, I.D. 85, 233, 235
Shrestha, H.G. 93
Sternheim, N. 220

Tatnall, A. 99, 233, 238
Taylor, R.G. 153
Telem, M. 9

Vaníček, J. 109
Visscher, A.J. 15

Wholeben, B.E. 162, 242
Wild, P. 27, 235

Yahalom, I. 170

# KEYWORD INDEX

Academic administrative systems 128
Administrative data processing 3, 9, 122, 139, 220, 225
Applications 179
  and expert systems 117, 134, 170
Applicative programming 147

CAI 209
CMI 209
Computer
  -aided engineering 93
    applications 3, 179
    administrative 153
  communications networks 109
  graphics applications 153
  and information science education 37, 109
  and society 179
  uses in education 3, 15, 27, 37, 46, 56, 79, 85, 99, 109, 122, 162, 170, 201, 209, 220
Computers 63
Computing mileux 3, 56

Database
  applications 50, 162
  management system 93
Diagnostics 195
Discrete mathematics 153
Distributed systems 117, 134

Education 9
Educational
  counselling 195
  management 63

Generate and taste method 187
Genetic algorithms 187
Governmental issues 79

Information search and retrieval 93
Information systems 3, 46, 50, 179
  applications 9, 85, 99
  interfaces 50
  technology 63
Information technology 195
Input/output and data communications 56

Management of computing and information systems 9, 15, 122
Microcomputers 85
Minicomputers 147
Miscellaneous 9, 56

Optimum combination problem 187
Organizational impacts 15, 27, 79, 99, 219, 220

Project and people management 9, 27, 37, 79, 93, 122
Public policy issues 46, 179, 215

Remote user access 128
Reports to parents and teachers 195

Schedule planning 187
School
  administration 63
  faculty consultation 195
Simulation support systems 162
Social
  and behavioural sciences 139, 179, 201
  issues 215
Software 187
  process management 201
Statistical data analysis 195
Student selection and placement 195
Systems and information theory 139

Types of system 46

User interfaces 117, 134
User/machine systems 3, 147

Voice response systems 128